ASIA PACIFIC INITIATIVE

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Prepared for

The Transportation Task Force
Asia Pacific Initiative Advisory Committee
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LABOUR MARKET STUDY OF THE BRITISH COLUMBIA AEROSPACE INDUSTRY

FINAL REPORT

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ASIA PACIFIC INITIATIVE

November 6, 1989

Hon. Mary Collins
Associate Minister of National Defence

Hon. Elwood Veitch
Minister of International Business & Immigration

Dear Ministers:

I am pleased to present a report on the skilled manpower needs of the B.C. aerospace industry and the economic cost of not meeting these needs.

The report concludes that there are already shortages of skilled workers in certain job categories and these shortages could reach crisis proportions if no action is taken. The economic cost to the province would be considerable. Based on moderate growth projections for the aerospace industry, an estimated 2250 jobs and $70 million in wages will be in jeopardy by the year 2000. On the other hand, the report states that there is a potential to create 6100 new jobs through the provision of expanded training facilities and the aggressive pursuit of current opportunities in the industry.

The Advisory Committee would like to acknowledge the time and assistance provided by members of the steering committee set up to direct the study. This group included representatives of national and regional carriers, manufacturers, educators, unions and government. Members of the group have offered their assistance to government in the implementation of the report's recommendations.

Yours sincerely

Peter Lusztig
Chairman

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Kirk Foley	APIAC
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EXECUTIVE SUMMARY

Around the world the aerospace industry has been experiencing exceptional growth. The Pacific Rim nations in particular have contributed to this growth and are forecast to continue their extraordinary level of demand for aerospace services.

Against this international backdrop, British Columbia's aerospace industry stands at a crossroads. One direction brings new levels of development and recognition as a "world class" aerospace centre. The other leads to the loss of jobs and economic development over the next decade.

To grasp its opportunities, both now and in the future, the industry must first grapple with the issue of skilled manpower. Skilled people are needed to service and maintain the airline fleets and to produce aircraft parts and components.

This study has identified significant shortages of skilled manpower existing today in certain job categories, shortages which could become acute soon. At present, the industry employs about 3,600 skilled workers in British Columbia. A survey conducted for the study shows the industry expects the need to rise to 5,000 by 1995 and 6,000 by the year 2000. This does not consider a further 1,100 workers expected to retire from the industry over the next decade. This represents a demand for 3,500 skilled people who must be attracted to the B.C. aerospace industry by the turn of the century, nearly double the existing level.

This estimate, however, is predicated on the growth pattern of past years. It does not consider the high levels of growth expected internationally. Such a high-growth scenario would require an additional 6,100 skilled workers to enter the British Columbia aerospace industry over the next ten years.

The following job categories have been identified as suffering skill shortages at present, with the shortages expected to deepen in the future:

1. Aircraft Mechanic
2. Avionics/Instrument Technician
3. Sheet Metal/Structures Technician
4. Upholsterer/Refurbisher
5. Engine and Accessory Mechanic
6. Machinist
7. Composites/Plastics Technician

The economic cost of failing to provide the skilled personnel required by the aerospace industry is considerable. It would prevent the industry from taking advantage of its opportunities. Such a negative growth scenario sees the existing industry in British Columbia losing jobs. Jobs would be lost

because of contract terminations, changes in company directions, or transfer of work to other provinces. Based on the industry's own normal growth projections, this translates into some 2,250 fewer jobs for the province. This would mean the loss of $70 million a year in wages for the provincial economy. More important it would mean the end of opportunity and expansion for this industrial sector. In the end, the aerospace industry of British Columbia would become moribund.

However, a high growth level is expected to provide an estimated 8,600 jobs. This can be accomplished by resolving manpower issues and aggressively pursuing current opportunities. This high growth would pour some $270 million a year in direct wages into the provincial economy.

Skilled labour is the key. Without trained workers, the entire future of the B.C. aerospace industry is threatened. It is an industry which generates $3.6 billion in annual revenue. It employs some 41,000 people, directly and indirectly, in the province today.

Traditional sources of such skilled manpower are limited. A general world-wide shortage of technicians and tradesmen has diminished the supply of skilled foreign workers. The military no longer releases a steady stream of skilled servicemen into the civilian marketplace. Personnel can no longer be attracted from other airlines and manufacturing firms since these companies are also competing for skilled people. Existing apprenticeship programmes tend to be haphazard.

This study recommends a coordinated aerospace training programme for British Columbia as the solution to the province's short- and long-term skill shortages. At present, Western Canadian aerospace training schools graduate fewer than 200 people per year. Nearly half of these graduates are attracted by other industries and leave the aerospace field. The demand for skilled people by the B.C. aerospace industry is expected to be 280 new people each year over the next decade. This requirement already exceeds the capacity of our training schools. If the skill demands of the high-growth scenario are to be achieved, more than 500 skilled workers will be needed each year. This is far beyond the capacity of the training schools.

British Columbia's aerospace training facilities must be expanded. This means increasing the number of qualified instructors. It also means providing training equipment. The number of courses being offered and the content of those courses must also be expanded.

Establishment of an aerospace "Centre of Excellence" within British Columbia is recommended. This facility would be the recognized focus for aerospace training in the province. Included are such diverse elements as flight training, management instruction and aerospace science training. Also included is the training of skilled workers. Among its activities would be assisting community colleges that wish to offer courses to local aerospace firms. Assistance would also be providing retraining courses for workers

already in the industry. Offering instruction for company-run apprenticeship programmes is another area that the "Centre" could provide assistance in.

The industry itself must lead the effort to rectify the skill shortages that it faces. Establishment of an aerospace coordinating group is recommended. This would be an industry-led organization. Participation would come from the training schools, unions, associations and both levels of government. This organization would provide the leadership required to address both the short-term and long-term training requirements of British Columbia's aerospace industry.

With this leadership, and with an aerospace Centre of Excellence, British Columbia will get the skilled manpower it needs to allow its aerospace industry to grow. Along with growth it will be able to take advantage of its Pacific Rim opportunities.

The time for action is now.

- - -

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1.0 INTRODUCTION

The Asia Pacific Initiative Advisory Committee (APIAC) is a private sector group established by the federal government and the Government of British Columbia to assist in identifying economic development initiatives for British Columbia with the Asia Pacific Region.

The Committee's Transportation Task Force identified the need for a study to determine the skilled manpower needs of the British Columbia aerospace industry. It recommended that a study be conducted that examined both the air transport maintenance and the manufacturing sectors of the aerospace industry. Concerns had been expressed by both sectors of the industry as to current and future shortages of skilled labour. These skill shortages could have a negative impact on aerospace initiatives which are planned to foster stronger aerospace links as well as to further trade and commerce between British Columbia and Pacific Rim countries.

A Steering Committee was formed to administer the proposed study. Representatives were from the Asia Pacific Initiative Advisory Committee, Canadian Employment and Immigration Commission (CEIC), Ministry of Advanced Education and Job Training, B.C. Federation of Labour, Ministry of International Business and Immigration, air carriers, and the aerospace manufacturing industry. APIAC and CEIC agreed to jointly fund the study.

The study Terms of Reference state the following objective:

> To undertake a labour market study and skills/training inventory of the current and future human resource requirements in the British Columbia Aerospace Industry and to assess the economic cost of not providing for these requirements.[1]

This report embodies the study Terms of Reference and meets the objective stated above.

Appendix A provides the full study Terms of Reference.

1.2 Aerospace Skill Category Definition

The labour categories in the aerospace industry include: design, research, development, production, marketing, repair and overhaul of aircraft, aeroengines and their related components or subsystems, space related equipment, and air/ground based avionics systems.

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[1] Terms of Reference, Labour Market Study of the British Columbia Aerospace Industry, March, 1989.

The study does not include skill categories related to air crew or other categories not directly related to aircraft service, repair and overhaul or aerospace manufacturing.

The following skill categories were included in the study:

- aircraft maintenance/systems/inspection
- aircraft structures
- aircraft avionics/systems/inspection
- non-destructive testing (NDT)
- mechanical and fuel system accessories
- electrical and electrical accessories
- interior design/upholstery, trim and fabrication
- instrument overhaul and repair
- machining and fitting, including computer numerically controlled (CNC) machine programming
- heat treating and processing
- sheet metal/composite fabrication and repair
- welding
- ground equipment maintenance
- engine repair and overhaul (piston/turbine/jet)
- aircraft painting and stripping

Appendix B provides details on the principal job descriptions of the above skill categories.

1.3 Study Approach and Scope

The study was conducted in ten separate phases. Each of the study phases contributed input into the next phases.

The principal work task was to develop a labour force inventory of the British Columbia aerospace industry. This was accomplished by conducting a survey of aerospace companies. A questionnaire was developed to obtain information on the labour force, skill shortage areas, future requirements, and training needs. This information was needed to develop a labour force profile. The questionnaire was mailed to smaller companies. Personal interviews were conducted with the larger firms. Comments and viewpoints on the aerospace skill shortages and training requirements were solicited.

Appendix C is a copy of the questionnaire sent to the aerospace companies.

A national air carrier labour study is also being conducted now. The Canadian Employment and Immigration Commission (CEIC), the Air Transport Association of Canada (ATAC), and various industry organizations and unions are conducting a national study for a Human Resource Study of the Canadian Aircraft Maintenance Industry. This study will examine the aircraft maintenance industry in Canada. It will include large air carriers, regional

air carriers, and general aviation. The study, however, does not address the aerospace manufacturing sector. The objectives of this companion study are:

1) through a dynamic assessment of the industry environment - with special emphasis on future trends and developments - to identify and assess the factors for all sub-sectors of the industry which will affect the magnitude and scope of future demand for AME "A"s, AME "E"s, aviation sheet metal workers, and other relevant maintenance occupations;

2) to examine, in-depth, changing technology with respect to the aircraft maintenance industry, and to assess the impact of changing technology on the skills of those occupations under review;

3) to develop an employment profile of the industry, with special emphasis on issues related to the supply of AME "A"s, AME "E"s and aviation sheet metal workers, and others as appropriate;

4) to identify and examine all issues with regard to training, including an examination of industry-education linkages;

5) to identify and examine any other human resources issues facing the Canadian aircraft maintenance manufacturing industry.[2]

1.4 Literature and Statistical Review

A comprehensive computer-based literature search was conducted to assemble available information concerning skilled labour in the aerospace industry. Information was obtained from several agencies, including Canada Employment and Immigration, Transport Canada, Aerospace Industries of Canada, Future Airline Professionals of America, Ontario Ministry of Skills Development, and other agencies concerned with skilled labour requirements in the aerospace industry.

Personal interviews were also conducted with the major air carriers, repair and overhaul firms, and aerospace companies included in the labour force survey. These interviews provided not only statistical information, but also comments on industry employment trends. The role of education in advancing skill qualifications and other issues affecting the supply of skilled

---

[2] Terms of Reference for a Human Resource Study of the Canadian Aerospace Maintenance Industry, March 7, 1989, p. 5.

aerospace workers were also discussed. Interviews were also held with the Pacific Aircraft Maintenance Association (PAMA), Western Canadian vocational schools, and union representatives of the aerospace industry.

Appendix D is a bibliography of the literature reviewed.

2.0 AEROSPACE INDUSTRY BACKGROUND

To provide a perspective of the role of skilled labour in the aerospace industry, a review was conducted of the aerospace industry

Both air carrier operations and aerospace manufacturing have been subject to rapid growth in recent years. It is estimated that the world aerospace industry revenue in 1987 totalled over $330 billion US, nearly double the 1980 figure of $178 billion US. Table A shows the air carrier and aerospace manufacturing revenues 1980-1987.

Table A

WORLD AEROSPACE REVENUE
(Billion U.S. $)

	Air Carrier Operating Revenues		Aerospace Manufacturing Revenues	
	WORLD	U.S.	WORLD	US
1980	87.676	33.728	91.160	54.697
1981	92.992	36.211	106.620	63.974
1982	93.240	36.066	112.930	67.756
1983	98.300	38.593	133.290	79.975
1984	105.200	44.060	139.140	83.486
1985	112.200	48.580	160.095	96.571
1986	124.600	50.086	176.775	106.066
1987	144.500	56.699	186.775	112.066

Source: ICAO - AIA

2.1 Airline Growth Trends

The International Civil Aviation Organization (ICAO) noted that in 1987 the world's airlines recorded some $144.5 billion U.S. in operating revenues and carried over one billion passengers. Traffic is expected to double again by 2000. There are currently over 6,900 jet airliners in the world. Both Boeing and McDonnell Douglas, two of the largest aircraft manufacturers, forecast over 11,500 jet airliners by 2000. In Canada and the United States, deregulation has resulted in fare reductions and increased frequency of service. Traffic has rapidly increased in response to market initiatives. Airlines in the U.S., for example, enplaned some 447.3 million passengers in

1987, compared to about 296.8 million in 1980. In Europe, the already crowded airports and airways will become busier after 1992. The European Common Market unification will increase business and pleasure travel between European countries. The Pacific Rim, with the strong economy of Japan and other Asian countries, is leading the world in high growth rates in air travel.

There is a world wide trend in the airline industry to become market driven. Deregulation in the United States in 1978 signalled the need for airlines to become more competitive and increase their market share. The United States airline industry was completely revised. A series of mergers and acquisitions, new service routes, hub and spoke traffic patterns, and the development of partnerships with commuter air carriers strengthened market positions. These market driven changes have now impacted other airlines around the world. Airlines which were previously owned by government, such as British Airways, Singapore Airlines, Japan Airlines, and Air Canada, were privatized, wholly or in part. This was done so that these airlines would be responsive to competition. Deregulation is now becoming evident in most European and Pacific Rim countries.

The airline industry is a capital intensive industry. More aircraft are needed to meet traffic demand. In part, the need for additional equipment is being met by aircraft leasing companies such as the GPA Group and ILFC. It is estimated that by the year 2000, some 3000 aircraft will be leased. This represents over 25 percent of the world fleet.

Another airline trend is the globalization of commercial agreements between airlines. These agreements can be:

(1) traffic marketing agreements such as those negotiated between British Airways and United Airlines, United Airlines and Alitalia, Canadian Airlines International and Lufthansa German Airlines, Air Canada and Cathay Pacific, Air New Zealand, Singapore Airlines, Royal Jordanian and Austrian Airlines.

(2) joint computer reservation agreements such as the Gemini reservation system which is owned by Canadian Airlines International, Air Canada and United Airlines. or

(3) equity participation.

It is in the area of equity participation that commercial agreements are becoming global in their influence. Equity participation allows airlines to increase their sphere of influence well beyond their home markets. A recent example is Iberia Airlines and Lufthansa German Airlines forming a new charter airline. British Airways and KLM Royal Dutch Airlines each contributed 20 percent of the share capital to form a new Sabena International Airline. The Belgian government owns the remaining 60 percent. KLM and Wings Holding Inc. recently purchased Northwest Airlines, one of the world's largest airlines, for $3.6 billion. Scandinavian Airlines System

(SAS) purchased 10 percent of Texas Air, the holding company for Eastern Airlines and Continental Airlines. SAS also has a 25 percent equity interest in British Regional Carriers, a consortium of United Kingdom airlines. Other equity participation agreements include Qantas Airways (20%), American Airlines (7.5%) and Japan Airlines (7.5%) in Air New Zealand and Japan Airlines 20 percent equity in Hawaiian Airlines. United Airlines and USAir shares are being sought by investors. British Airways wishes to purchase 25 percent of United Airlines. It is expected that airline globalization trends will increase, particularly in the early 1990's as airlines develop their market strategies for a unified Europe and a strong Asian economy.

2.1.1 Pacific Rim Air Travel

"The Asia/Pacific area is one of the brightest parts of the air transportation picture ... By the early 1990's, the region will account for more than one-third of international air traffic - more than the European marketplace."[3]

Pacific Rim air travel provides British Columbia with several opportunities for its aerospace industry. British Columbia's strategic position between Asian, European and North American markets provides it with an advantage. It can benefit from Asia/Pacific trade and commerce links.

Pacific Rim air travel has been growing at a rapid rate over the past few years. The FAA recently updated its forecasts of transpacific commercial air carrier passenger traffic and operations.[4] This forecast expects passenger traffic to increase at an annual rate of 7.8 percent between 1989 and 2000, from 11.8 million to 29.2 million. Commercial aircraft operations are forecast to increase at an annual rate of 6.8 percent over the same period, from 52,000 in 1988 to 114,000 in 2000. The transpacific is currently served by 30 commercial air carriers.

Eight transpacific airlines service Vancouver. They connect British Columbia to Tokyo, Hong Kong, Seoul, Beijing, Shanghai, Bangkok, Singapore, Nagoya, Auckland, Brisbane, Cairns, and Sydney. It is expected that soon additional air carriers and transpacific routes will be added. There are now 600,000 passengers who travel between Vancouver and Pacific Rim destinations. By the year 1995, over 1.1 million will travel on these transpacific routes, nearly double the current figure. The value of air cargo using Vancouver as a

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[3]Eser, Gunther, Director General: ATA, Speed to Orient Airline Association, Sydney, Australia, November 1986.

[4]Mercer, Gene, Federal Aviation Administration, "Trans Pacific Commercial Air Carrier Operations Forecasts 1989-2020", presented to Airshow Canada Symposium - Looking to 2020, Vancouver, BC, August 8, 1989.

gateway to Pacific Rim countries is now about $175 million. By 1995 the value is expected to increase to over $300 million.[5]

The Boeing 747-400 series aircraft, the first of the new generation of ultra-long range aircraft, will change Pacific Rim travel. Also included in this class of aircraft are the Airbus A340 and the McDonnell Douglas MD-11. These last two are expected to enter service in the early 1990's. Asian air carriers have ordered nearly half of these new long-range aircraft for the transpacific and Asia Pacific routes. These aircraft can be viewed as either an opportunity or a threat to British Columbia. The long range capability (7,145 nm) of the Boeing 747-400 allows it to provide direct service between Toronto and Tokyo and bypassing Vancouver. On the other hand, it can provide Vancouver with direct routes to Bangkok, Singapore, and Auckland. Additional direct routes connecting British Columbia to Asia Pacific countries will enhance its Pacific Rim stature.

British Columbia can expect to benefit from air travel links to Pacific Rim countries if it continues to attract new air carriers and new route services. Airport capacity, at Vancouver International Airport, must be available, however, to see continued growth of air passengers and air cargo.

2.2 Aerospace Manufacturing Growth Trends

The aerospace manufacturing sector is also undergoing a globalization trend. Aerospace manufacturing now takes place in several countries including Brazil, Argentina, Indonesia, India, Pakistan, Singapore, South Korea, Australia, and China in addition to Europe and North America. International joint ventures are being formed between major aerospace manufacturers to share development risks and to capture a larger market share. The Airbus consortium is the best known of the international aerospace joint ventures. Airbus is owned by Aerospatiale of France, British Aerospace of the United Kingdom, MBB of West Germany, and CASA of Spain. The Airbus consortium, in turn, sub-contracts to other firms in Europe and North America, including Grumman Aerostructures, Canadair, Textron Aerospace, Lockheed-Georgia, McDonnell Douglas, and Dassault-Breguet. Boeing Commercial Aircraft Company sub-contracts about half of their aircraft work to other aerospace manufacturers. The Boeing 747-400, for example, has its tail section built by Vought Systems, the fuselage by Northrop, flaps by Mitsubishi, wing extension by Korean Air, and wing leading edge by Short Brothers. Figure 1 shows the major sub-contractors of the Boeing 747. In total, some 1500 firms in 20 U.S. states and 12 international companies are involved with building the Boeing 747. The McDonnell Douglas MD-11 also has risk sharing partners. Sub-contractors include CASA (horizontal tail), Aeritalia (winglets), Mitsubishi (tail cone), Fuji Heavy Industries (ailerons), and General Dynamics, Convair Division (fuselage).

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[5] McNeal & Associates Consultants Ltd., Pacific Rim Aviation Impact Study, Transport Canada, Vancouver, April 1986.

747-400 MAKE OR BUY

- AERONCA/DAEWOO, KOREA*
- AUBURN
- BOEING, CANADA/WINNIPEG
- BOEING, PORTLAND
- CLEVELAND PNEUMATIC
- EVERETT
- FUJI, JAPAN
- HAWKER de HAVILLAND, AUSTRALIA
- HEATH TECHNA
- KAWASAKI, JAPAN
- MITSUBISHI, JAPAN
- NORTHROP
- PRATT & WHITNEY
  GENERAL ELECTRIC
  ROLLS ROYCE
- ROCKWELL INTERNATIONAL
- ROHR INDUSTRIES
  WICHITA
  BRITISH AEROSPACE/EVERETT
- SHORT BROS & HARLAND
- SIERRACIN
  PPG INDUSTRIES
  TRIPLEX (PRIME)
- BOEING HELICOPTERS/XIAN, CHINA**
- VOUGHT SYSTEMS
- WICHITA
- KOREAN AEROSPACE***

* Dual source C/L 742 to C/L 890 then DHI sole source and on.

** Dual source L/N 881 and on.

*** Dual source with Everett L/N 782 until L/N 848.

May, 1989

Other aerospace joint ventures include the major engine manufacturers. International Aero Engines, developing the V-2500 engine, is a consortium of Pratt & Whitney, Rolls Royce, Japanese Aero Engines, Motoren und Turbinen Union (MTU), Fiat Aviazione, and Hispano-Suiza. CFM International is a successful consortium of General Electric of the U.S. and SNECMA of France.

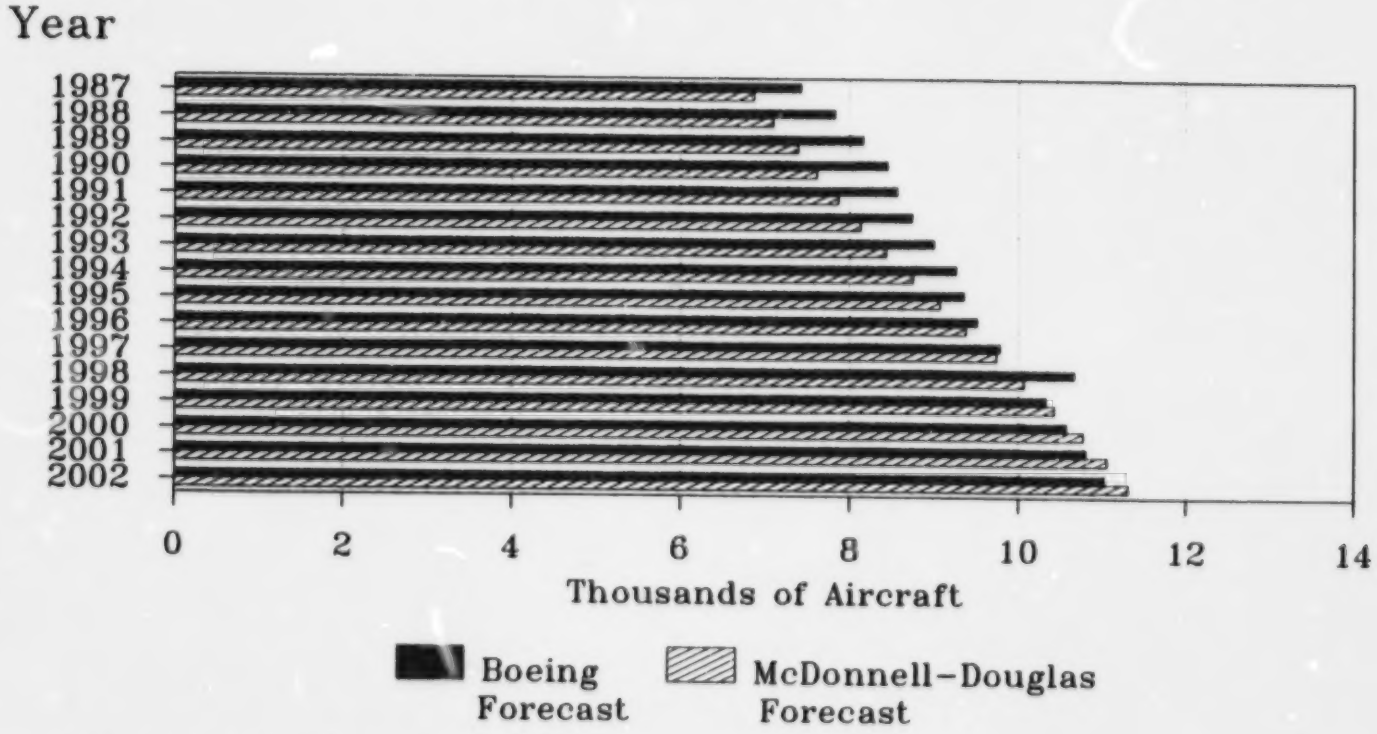
The capital investment of new aircraft and engines is large. McDonnell Douglas estimates that the development of a new aircraft now requires an investment of $2-4 billion US. In 1940, when Douglas developed the four-engine DC-4, the development cost was only $1 million. The financial risk is now beyond one company to finance and risk sharing partners are needed. Consortia and loans have been developed to take a financial share in projects. A sub-contractor's financial commitment may be several millions of dollars for loan guarantees to the prime aircraft manufacturers. In addition, it bears the costs for its own development costs of tooling and sub-assembly equipment. These costs are all at risk, contingent on the commercial success of the venture.

Specialized technology is advancing in the aerospace industry. New materials such as engineering composites, aluminum/lithium graphite, and titanium aluminides are being introduced for their light weight and strength. New manufacturing techniques are being used such as investment castings, super plastic forming, diffusion bonding, powder metallurgy, automated vacuum casting, electronic beam welding, water jet cutting, robotics, laser cutting, hot isostatic pressing (HIP), and computer numerically controlled (CNC) milling and machining. Technology is also advancing in areas such as flight controls ("fly-by-wire"), cathode ray tube (CRT) displays, electronic flight information systems (EFIS), ceramic engine burner units, high temperature intermetallic materials, computer assisted controls, on-board sensors and monitors for flight parameters, instrument/navigation, and engine maintenance requirements.

Because of the boom in air travel demand noted earlier, airplane orders began to increase in the mid-1980's and have skyrocketed in the last two years. Bookings totalled nearly 3,200 new aircraft between 1985 and 1988. The current backlog is 3,500 airplanes. Boeing forecasts that airlines will purchase or lease more than 8,400 new aircraft, worth over $500 billion US, during the next 15 years. Boeing, the largest airplane manufacturer, has 65 percent of the world market. It has a backlog of over $80 billion U.S. in orders. Airbus has 20 percent of the market in new aircraft sales and currently has a backlog of $35 billion US. McDonnell Douglas, manufacturer of the MD-80 series and the new MD-11 airplane, has 12 percent of the market share and a backlog of orders worth $18 billion US. Fokker, the Dutch manufacturer, and British Aerospace have 3 percent of the market. Fokker has a backlog of $4 billion U.S. in orders for its F-100 jet airliner and F-50 turboprop. British Aerospace has a backlog of $2 billion U.S. for its BAe 146 jetliner, ATP turboprop, and Jetstream 31 turboprop. Sub-contractors to the prime aerospace manufacturers, including Canadian firms, are also benefitting from the many aircraft on order.

The major aerospace manufacturers expect the number of jet airliners to increase to nearly 12,000 by the year 2000. Figure 2, overleaf, shows the jet fleet forecasts of both Boeing and McDonnell Douglas. These forecasts consider retirements from the fleet due to noise regulations, aging aircraft, and economics. Figure 3 shows the annual expected retirements. Figure 4 shows the expected annual deliveries of jet aircraft for each year of the Boeing and McDonnell Douglas forecasts.

Commercial Aircraft Inventory
Total for the World
1987–2002



Current Market Outlook, Boeing, 1988
Outlook for Comm. Aircraft, MD, 1989

Figure 2

Aircraft Retirements
Aging Aircraft Total for the World
1987–2002

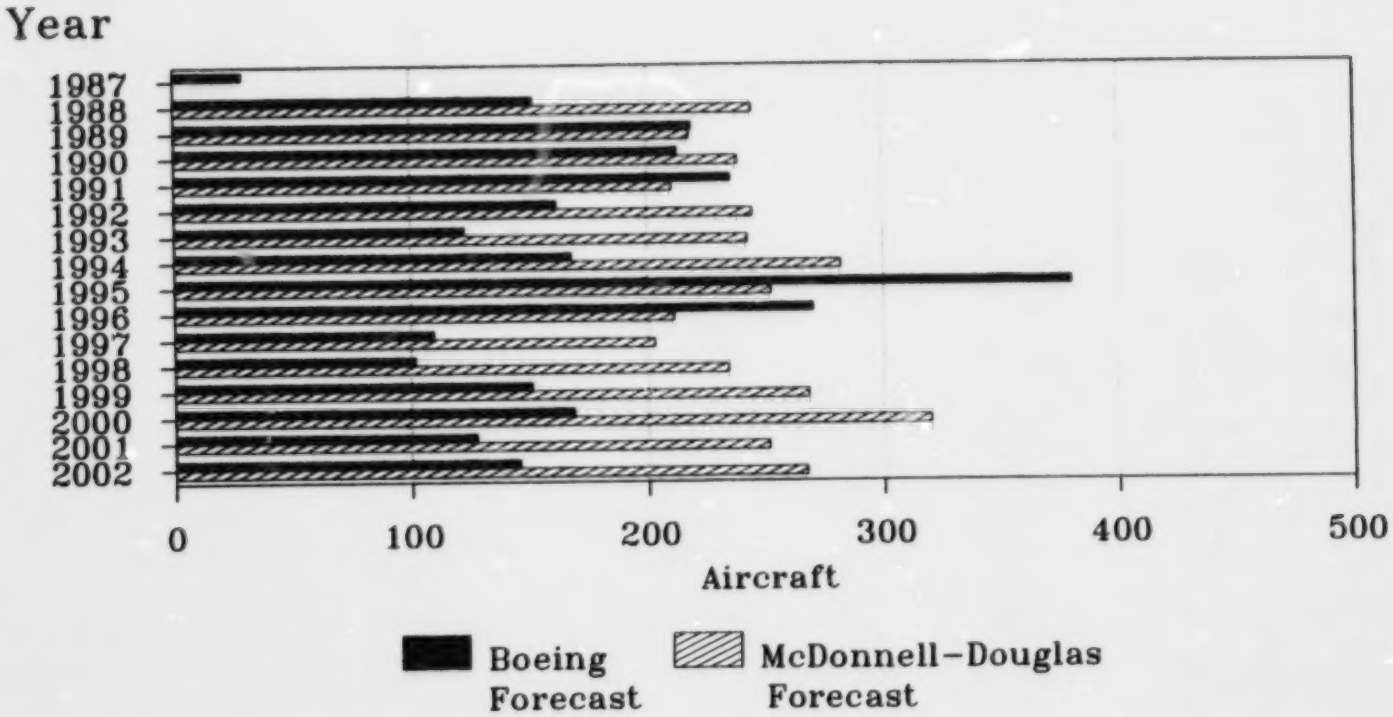
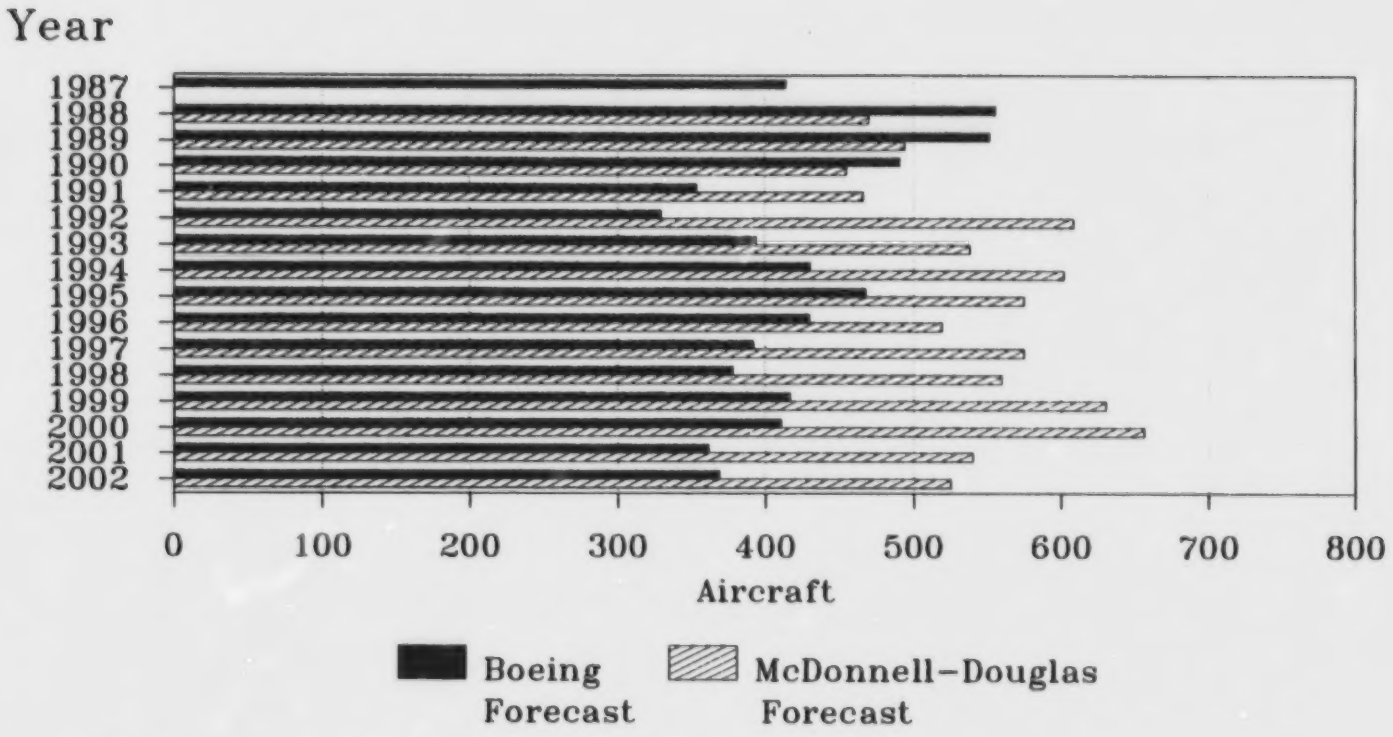


Figure 3

Current Market Outlook, Boeing, 1988
Outlook for Comm. Aircraft, MD, 1989

New Aircraft Deliveries
Total for the World
1987–2002



Current Market Outlook, Boeing, 1988
Outlook for Comm. Aircraft, MD, 1989

Figure 4

3.0 CANADIAN AEROSPACE INDUSTRY

The Canadian aerospace industry reflects the growth noted in the US, European and Pacific Rim countries. This section presents highlights of the Canadian industry. It also addresses changes which are taking place to the airlines and the aerospace manufacturers.

3.1 Air Carrier Industry

Traffic in Canada has doubled from 1980 to 1987. Over 31.8 million passengers and 596,000 tonnes of cargo were carried in Canadian operated aircraft in 1987. The major Canadian carriers in 1987 recorded over $6.3 billion in operating revenue and an operating income of $346.1 million.

Deregulation started in Canada in May, 1984 when the federal government announced plans to partially deregulate the domestic airline industry. In July, 1985, a Freedom to Move paper was issued proposing a new criterion for air carrier service based on "fit, willing and able."[6] August, 1987 saw the introduction of the amended National Transportation Act which became law on January 1, 1988.

CPAir, the nation's second largest air carrier decided in 1984 that acquisitions and affiliations were the most effective means of competing with the larger Air Canada in a deregulated environment. In 1984, CPAir acquired Eastern Provincial Airways (EPA) and, in the following year, Nordair. After these mergers, CPAir changed its name to Canadian Pacific Airlines (CPAL). In December, 1986, PWA Corporation, the parent company of Pacific Western Airlines, bid $300 million for Canadian Pacific Airlines. These two airlines merged in February 1987. Wardair, formerly an international charter service, began operating as a scheduled transcontinental air carrier in 1987. For the next 18 months Canadian Airlines International, Air Canada, and Wardair entered into cut-throat fare competition. The competition ended with PWA Corporation making a $248 million bid in January, 1989 for control of Wardair. In April 1989, the agreement of sale was finalized. Canadian Airlines International also has Partnership agreements with commuter air carriers. These now include Time Air, Norcan Air (Time Air), Air Atlantic, Calm Air, Ontario Express and Inter-Canadian. Equity has been contributed to some of these commuter air carriers by Canadian Airlines International.

Air Canada, in the meantime, was privatized by the federal government. In April, 1988, the federal government announced its intention to introduce legislation to permit the privatization of Air Canada and the transfer of its shares to the public. In October, 1988, an initial public offering of 45% of Air Canada stock was completed with net proceeds of $234 million to Air Canada. The federal government sold the remaining 55 percent of the shares (fully diluted) to the public in July, 1988. The selling of the shares

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[6] Freedom to Move: The Legislation, Transport Canada, TP 7749, p. 5.

provided nearly $500 million to the federal government. Air Canada has bought control of several commuter air carriers. These carriers include Air Nova, Air Ontario, AirBC, Northwest Territorial and Air Toronto. The control ensures Air Canada retains its traffic feed at its main Canadian traffic hubs.

The major airlines of Canada have recently added to their aircraft fleets and plan to continue adding new aircraft into the 21st century. See Table B.

Air Canada currently has a fleet of 116 aircraft. It has ordered an additional 47 aircraft and has options for a further 36 aircraft. The new aircraft are Airbus A320's to replace the Boeing 727's and Boeing 767-300ER to replace the Lockheed L-1011's. The new Boeing 747-400's are planned for future Pacific routes. No decisions have been made to replace the DC-9 fleet.

Canadian Airlines International currently has a fleet of 87 aircraft. Orders have been placed for an additional 15 aircraft and options are held on a further 52 aircraft. The A320-200 will replace some of the Boeing 737's. The Boeing 747-400's will be used on the Pacific routes and the Boeing 767-300's on other international routes.

Wardair has 15 aircraft in its fleet. It had planned to purchase an additional 35 short range aircraft. However, with the airline's acquisition by PWA Corporation, these orders have been dropped.

Airlines in Canada in 1987 employed some 46,500 persons. The total wages were $1.6 billion based on an average wage of $35,900. Table C shows the historical employment levels in the Canadian airline industry. The PWA Corporation (including Canadian Airlines [18,000] and Wardair [4,500]), together with Air Canada, employ some 44,000 people, nearly 95 percent of the total Canadian airline employment.

Airlines in Canada in 1987 allocated some 11.3 percent of their total operating expenses to the maintenance of the aircraft fleet. The total aircraft maintenance expenditures were $659,919,000 - down 3 percent from 1986. Labour costs for maintenance were $226,323,000 and materials and supplies the remaining $433,596,000. Air Canada has the most direct aircraft maintenance employees in Canada with 2,833 in 1988. Canadian Airlines International ranks second with 1,949 and Wardair third with 296 people. These employee figures do not include maintenance support personnel or ground equipment maintenance personnel.

Table B

AIRLINES OF CANADA FLEET ADDITIONS

	Current	Order	Option
Air Canada			
Boeing 747-400 Combi	-	3	4
Boeing 747-100 & -200	6	-	-
Lockheed L-1011*	14	-	-
Boeing 767-200	21	-	-
Boeing 767-300ER	-	6	12
Airbus A-320	-	38	20
Douglas DC-9	36	-	-
Boeing 727**	33	-	-
DC-8F (cargo)	6		
	116	47	36
Canadian Airlines International			
Boeing 767-300 ER	8	2	14
Boeing 737-200*	66	-	-
Boeing 747-400	-	3	4
Douglas DC-10-30	13	-	-
Airbus A320-200	-	10	34
	87	15	52
Wardair			
Boeing 747-100	3		
Airbus 310-300	12		
	15		

* to be replaced by B-767-300ER
** 28 sold to Federal Express for delivery 1990-92

* 8 to be sold in 1991

Source: The Canadian Airline Industry and PWA Corporation/Canadian Airlines International: Canada's Best Positioned Airline, Merrill Lynch, Canada, December, 1988, pp. 24, 28, 34 and various trade publications.

Table C

AIRLINES IN CANADA EMPLOYMENT
AND PAYROLLS

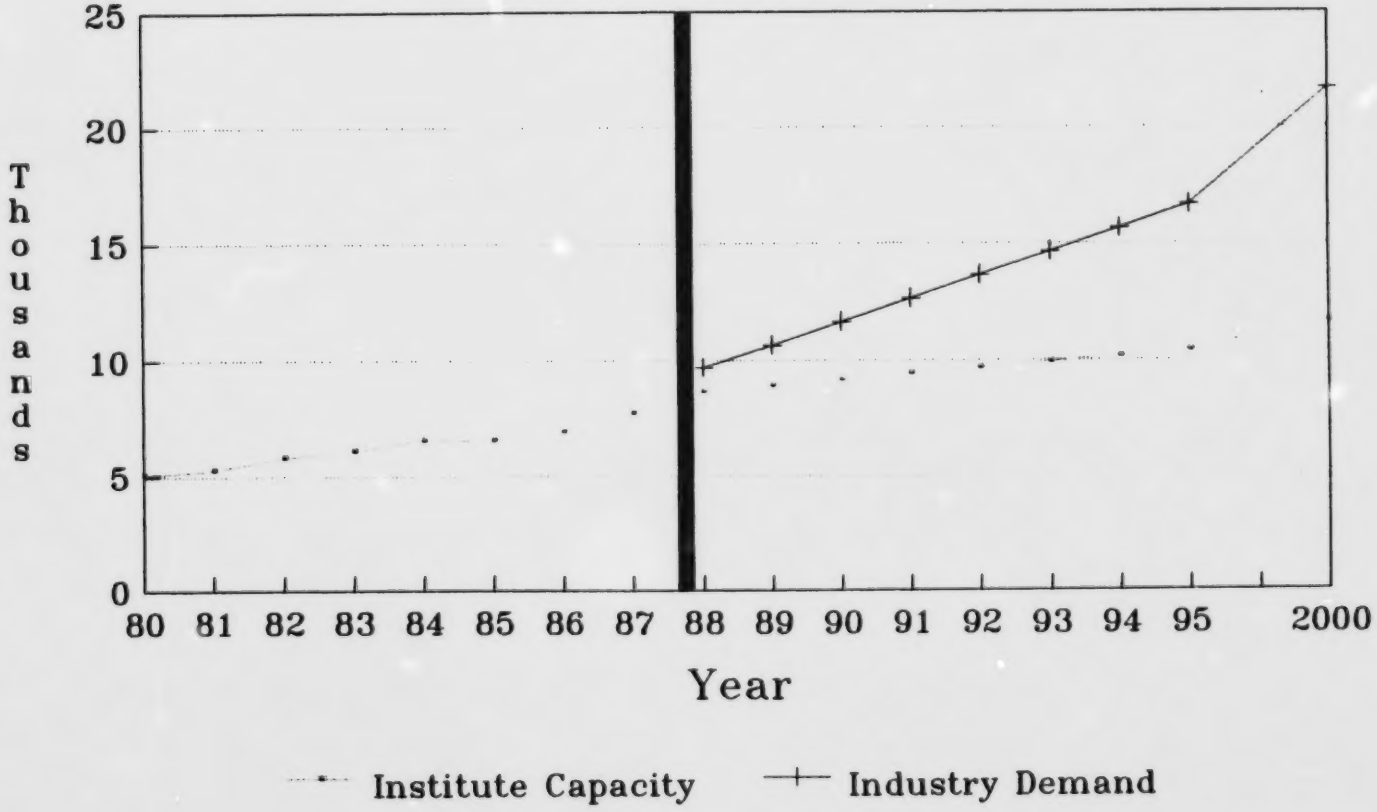
	Employees	(million $ Cdn) Total Wages	($ Cdn) Average Wage
1980	47,676	$1,124.7	$23,591
1981	47,451	$1,275.4	$26,879
1982	45,707	$1,372.9	$30,037
1983	42,093	$1,370.8	$32,568
1984	42,282	$1,431.9	$33,868
1985	43,330	$1,527.4	$35.251
1986	45,489	$1,630.9	$35,854
1987	46,501	$1,669.0	$35,889

Level I-III Air Carriers
Source: Air Transport Association of Canada

3.1.1 Canadian AME Profile

The total number of Transport Canada licensed Canadian Aircraft Maintenance Engineers (AME's) is 8,660 in 1988. Figure 5 shows the historical and forecast growth in the number of AME's. Transport Canada's AME forecast indicates a requirement for 22,000 AME's by the year 2000. Transport Canada also predicts that only 12,000 may be available due to the current capacity limitations of Canadian AME training institutions. The number of AME's in Transport Canada's records includes those people who may have retired in the last five years, those who may be working outside of Canada and hold a Canadian licence, and those who are not currently working for any Canadian airline. The regional distribution of AME's by Transport Canada regions is shown in Figure 6. The figure indicates there are 1,800 licensed AME's in the Pacific Region (British Columbia). The Pacific AME Association, however, estimates that only 1,200 of these people are likely active AME's in the province. Figure 7 shows the age group of Canadian AME's and indicates the majority are in the 30-39 year range. The figure also shows that nearly 30 percent of the AME's are over 50 years of age. These individuals are approaching retirement age. Figure 8 shows the distribution of AME licences by category (present classification). Over 70 percent of the AME's hold an aircraft mechanic "A" category rating. An avionics "E" rating ranks second with 11 percent of the total and a helicopter mechanic "R" rating third with less than 10 percent of the total.

Licensed Aircraft Maintenance Personnel
Canadian AME's



Source: Transport Canada

Figure 5

Figure 6

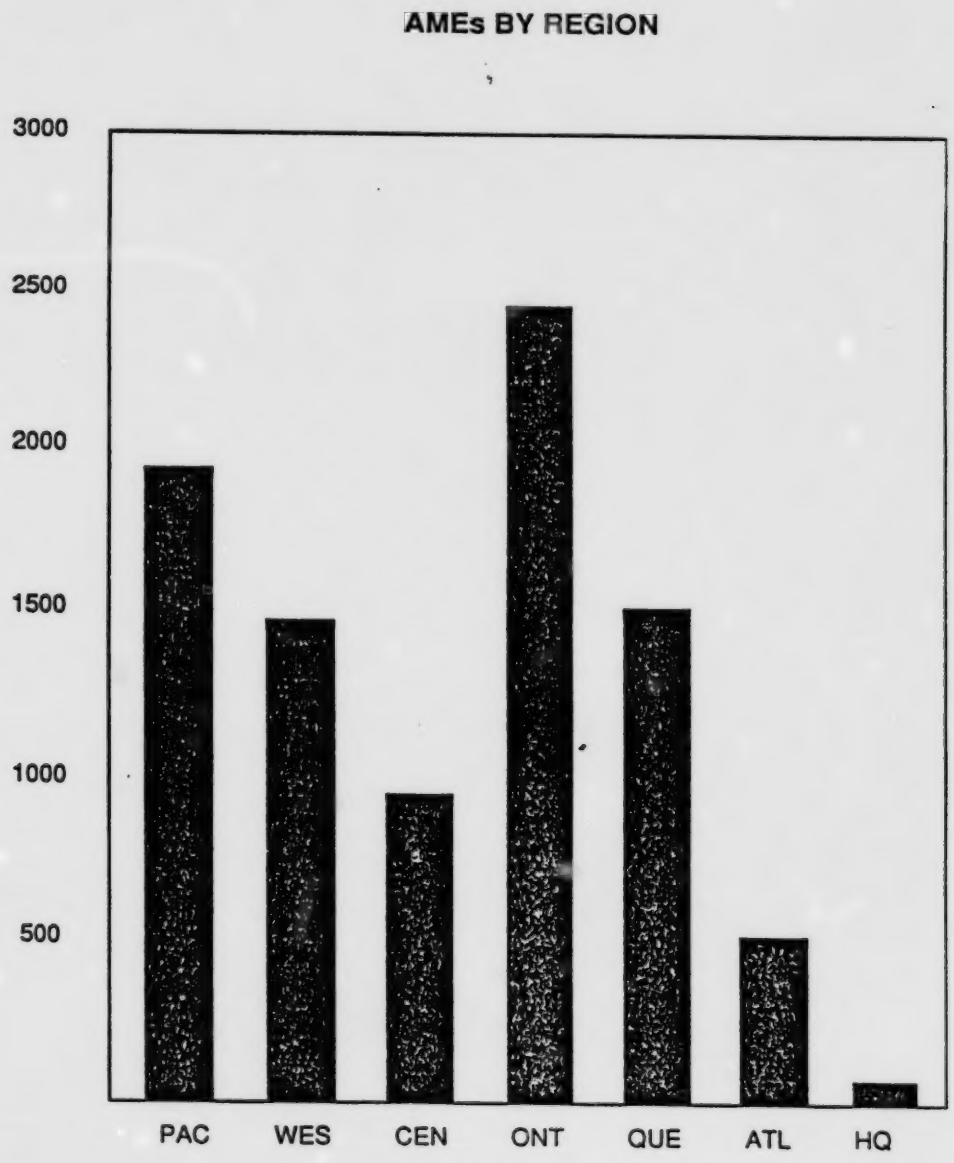

AMEs BY REGION
3000
2500
2000
1500
1000
500
PAC
WES
CEN
ONT
QUE
ATL
HQ

Figure 7

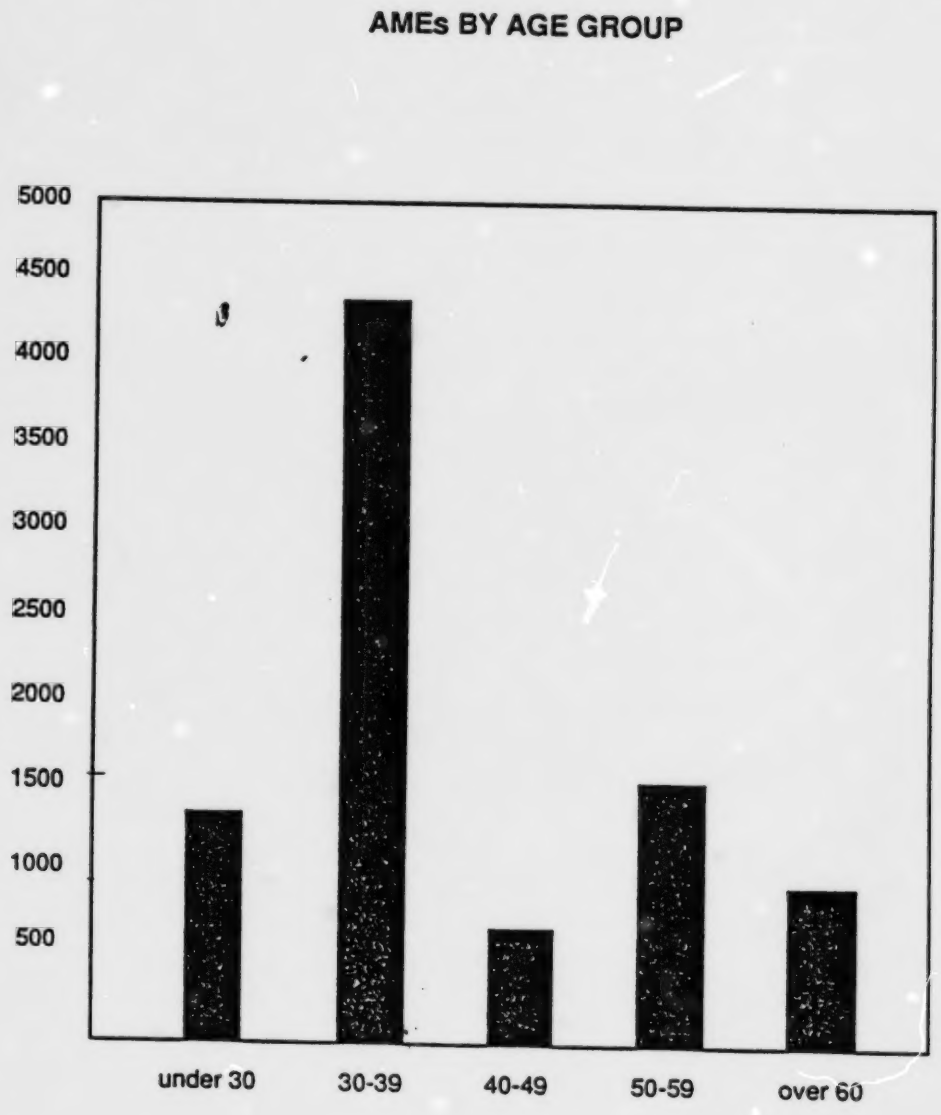
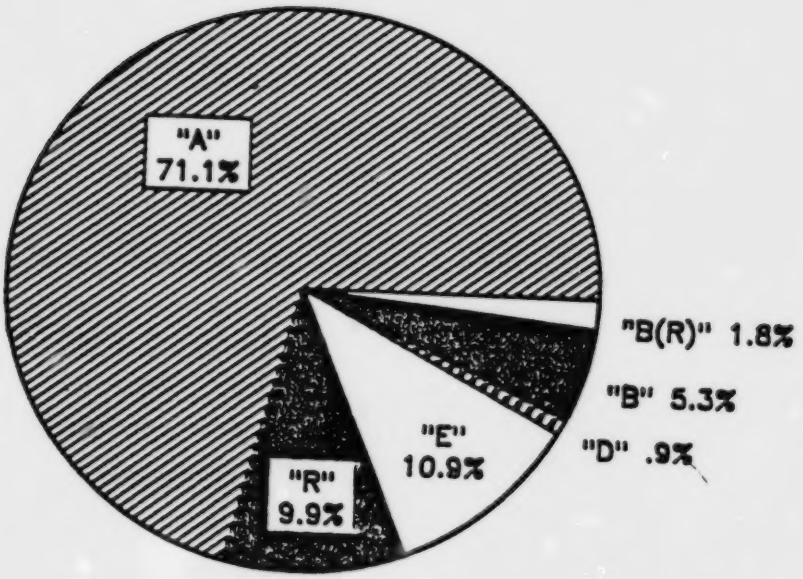

AMEs BY AGE GROUP
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
under 30
30-39
40-49
50-59
over 60

Figure 8

AMEs BY CATEGORY
(PRESENT SITUATION)



3.1.2 Maintenance Profile of Major Canadian Airlines

Canada's three main airlines are profiled below as to their aircraft maintenance capabilities and respective facilities.

3.1.2.1 Air Canada

Air Canada's principal maintenance centre is located at Montreal's Dorval Airport on 150 acres of land. The Dorval maintenance base includes an aircraft maintenance hangar (11 hangar bays totalling 423,000 sq. ft.), stores, test centre, ground equipment, workshops, computer centre and training centre. The building complex is 1.6 million square feet in size. Maintenance for the Lockheed L-1011, Boeing 747 and 767, DC-8 and DC-9 is conducted at the base. This maintenance includes major "C" and "D" checks. The Boeing 727, as well as some Douglas DC-8 and DC-9, maintenance is done at the Winnipeg maintenance complex. This 250,000 sq. ft. building in Winnipeg includes aircraft maintenance hangars, support workshops and some equipment storage. The new Airbus A320 will be maintained at the Winnipeg maintenance base. Air Canada also has line maintenance bases at London (England), Halifax, Toronto and Vancouver.

The Maintenance and Engineering Branch is composed of five divisions:

- Aircraft Maintenance and Flight Support Ground Equipment (2,400 employees)
- Power Plant Units (1,400 employees)
- Maintenance Quality (350 employees)
- Engineering (100 employees)
- Planning (85 employees)

Air Canada can repair 98 percent of its fleet's aircraft accessories and components. In 1988, it also conducted $60 million in aircraft maintenance for over 40 third party airline customers. The maintenance bases at Dorval and Winnipeg are operated 24 hours a day to support the fleet. Air Canada operates a large 14,000 sq. ft. avionics department in Montreal. It uses automated test equipment capable of supporting the new A320 "fly-by-wire" avionics. The engine shop, also in Montreal, is capable of handling all the engines in the fleet. The engine test cell will be modified to allow testing of the CFM-56 engine on the A320 aircraft.

3.1.2.2 Canadian Airlines International

Vancouver is the main overhaul and repair maintenance base for Canadian Airlines International. The 550,000 sq. ft. maintenance complex includes aircraft maintenance hangars (four wide body bays) offices, stores, training centre, and workshops. The company carries out the majority of its maintenance checks in house. Aircraft "C" and "D" checks, engine overhauls, avionics repairs, and instrument calibration are done at the Vancouver facility. Most hydraulic components are repaired and serviced here as well.

The $20 million engine test facility can test both the Pratt & Whitney JT-8 and General Electric CF6 engines. Canadian Airlines International can overhaul the entire engine except the core of the CF6. It expects to maintain the CFM International CFM-56 engine on the A320 aircraft when these are delivered. The avionics shop has automated digital test equipment, but currently only analog equipment can be repaired. It is expected the digitized avionics and instruments in the Boeing 767 and A320 will be sub-contracted after the warranty period has expired. Currently this type of work could not be carried out in British Columbia.

Due to the amalgamation of four airlines (CP Air, PWA, Nordair, Eastern Provincial), Canadian Airlines International operates three shifts in each department to keep up with the maintenance needs of the expanded fleet.

In addition to its Vancouver facility, the company has line maintenance bases in Calgary, Edmonton, Toronto, Montreal and Halifax. With the recent acquisition of Wardair, it is likely that the Toronto maintenance capabilities will be expanded. The A320 maintenance could be handled at an expanded Toronto maintenance centre. Canadian Airlines International has a total maintenance staff of 3,400 including ground equipment maintenance and support. It is by far the largest aerospace employer in British Columbia.

3.1.2.3 Wardair Canada

Toronto is the maintenance centre for Wardair. It has a large wide body hangar which accommodates aircraft maintenance office, stores and workshops. Maintenance on the Boeing 747 and Airbus A310 are conducted at the facility, including "C" and "D" aircraft checks. Wardair has an engine shop and can replace engine modules. Wardair, however, uses Air Canada's test facility for the Pratt & Whitney JT-9D engines and the Airbus facilities in France for the CF6 series of the A310. Wardair does not have an avionics repair shop but can conduct small item repairs.

Wardair currently has a total maintenance staff of 550 including ground equipment maintenance and support. Wardair had planned to add 100 more maintenance staff to handle the planned Fokker 100 and McDonnell Douglas MD-88 purchases. The acquisition by PWA Corporation has cancelled this requirement. The maintenance complex, however, could be used by Canadian

Airlines International to rationalize maintenance needs between Toronto and Vancouver.

3.2 Aerospace Manufacturing

The Canadian aerospace manufacturing sector has become a technology intensive industry. The industry ranks fifth in the world's aerospace industry countries. In 1988, the Aerospace Industries Association of Canada (AIAC) estimated that Canadian aerospace sales totalled $6.12 billion. It also projected that total sales will reach $8.9 billion by 1992. Exports of aerospace products in 1988 were about $4.8 billion, indicating that about 77 percent of the products are exported out of Canada. Most of the exports were to the United States (70%). It is projected that aerospace exports will increase to $6.8 billion by 1992. Current investment by Canadian aerospace firms is about $93 million in plant and $297 million in equipment.

The aerospace manufacturers' markets include prime transport and general aviation aircraft manufacturers, regional airlines, business aircraft users, major defense and commercial aerospace contractors and governments. About 45 percent of total sales generated in Canada are attributable to four large companies: Pratt & Whitney Canada Inc., Canadair Inc., Boeing Canada, deHavilland Division, and Bell Helicopter Canada Ltd. Each of these large companies recorded sales of over $400 million. Another group of 40 companies (sales between $20 million to $400) contribute an additional 45 percent of the total sales. The major firms in this second group include: McDonnell Douglas Canada Ltd., Menasco Aerospace Ltd., Garrett Canada, Fleet Corporation, Spar Aerospace Ltd., Bristol Aerospace, Rolls Royce Canada and Standard Aero. There are approximately 140 other firms which account for the remaining 10 percent of industry sales. All the British Columbia aerospace firms have less than $20 million in sales and are included in the latter category of small firms.

Aerospace manufacturing is located mainly in Ontario and Quebec (93 percent of total Canadian production). Table D, overleaf, shows the regional distribution.

The industry is highly specialized with only limited direct competition among firms. In terms of sales volume, the composition of the industry is:

- Airframe - 39%
- Propulsion - 33%
- Avionics - 23%
- Space - 5%

The industry's strong sales growth in recent years has been a result of aerospace opportunities in the United States market. United States deregulation and the growth of the airline industry has benefited such firms

Table D

CANADIAN AEROSPACE MANUFACTURING DISTRIBUTION

	Atlantic	Quebec	Ontario	Prairies	B.C.
Employment (% of total)	1.0	43.0	50.0	5.0	1.0
Shipment Value (% of total)	1.9	41.1	48.2	7.4	1.4

Source: Industry Science and Technology Canada

as Pratt & Whitney, Canadair and deHavilland with the increased demand for turboprop and turbofan engines, as well as commuter and corporate aircraft.

The Canadian aerospace manufacturing industry has acquired a product development capability and has incorporated research and development technology into new designs. Technology advancement is fundamental to the growth of the aerospace market. To adapt to technology changes, Canadian aerospace firms are employing modern methods of production. Essentially, all firms use computer numerically controlled (CNC) machine tools and a growing proportion have CAD/CAM capability. Research and development and new manufacturing technologies are expected to allow the industry to remain competitive in price, delivery and after sales service.

The Canadian aerospace manufacturing industry in 1988 employed some 61,000 people - a 60 percent increase over the 1980 employment level. AIAC projects that by 1992 nearly 70,000 will be employed in the Canadian aerospace manufacturing sector. Assuming similar ratios between total employment and production workers as in the United States, the number of production workers in the Canadian aerospace industry in 1988 is estimated to be over 20,000. By 1992, this employment figure can be expected to increase to nearly 23,000 skilled production workers.

4.0 BRITISH COLUMBIA AEROSPACE INDUSTRY

The British Columbia aerospace industry provides a diverse range of air transportation services and aerospace products and services.

The industry also is a major contributor to the provincial economy. Based on the information in the Transport Canada study of "The Economic Impact of Vancouver International Airport," it is estimated that the entire British Columbia aerospace industry generates $3.6 billion in economic output of which $1.9 billion is direct economic output. It provides direct employment of over 16,000 people and sustains a total of 41,000 jobs in the province. Based on the growth rates assessed for Vancouver International Airport, by the year 2000 the British Columbia aerospace output is expected to be $6.6 billion. The employment generated is forecast to be more than 66,000 jobs.

Table E shows the estimated annual economic output of the British Columbia aerospace industry. Table F illustrates the estimated employment of the British Columbia aerospace industry. The tables show direct and indirect multiplier effect. They also show the impact on the related commercial service, travel, and ground transportation industries.

Table E

BRITISH COLUMBIA AEROSPACE INDUSTRY
ECONOMIC OUTPUT - 1987

(Millions of Dollars Per Year)

	DIRECT	INDIRECT	INDUCED	TOTAL
Air Carriers	930	390	386	1,706
General Aviation	340	144	140	624
Manufacturing/Support	192	82	72	346
Airport Admin. & Operations	214	102	110	426
Commercial Services	54	12	30	96
Tourist/Travel/Hotels	170	80	70	320
Ground Transportation	60	30	24	114
GRAND TOTAL	1,960	840	832	3,632

Source: Based on Vancouver International Airport: Economic Impact Study Update - Final Report, Transport Canada, May, 1989.

Table F

BRITISH COLUMBIA AEROSPACE INDUSTRY
EMPLOYMENT - 1987

(Person-Years)

	DIRECT	INDIRECT	INDUCED	TOTAL
Air Carriers	9,300	4,560	6,230	20,090
General Aviation	1,780	1,644	2,898	6,322
Manufacturing/Support	1,880	1,666	1,108	4,654
Airport Admin. & Operations	820	1,640	1,742	4,202
Commercial Services	300	186	464	950
Tourist/Travel/Hotels	1,650	998	1,030	3,678
Ground Transportation	825	286	318	1,429
TOTAL	16,555	10,980	13,790	41,325

Source: Based on Vancouver International Airport: Economic Impact Study Update - Final Report, Transport Canada, May, 1989.

The principal sectors are described in the following sections.

4.1 Air Carrier

The air transportation sector employs over 11,000 in British Columbia. The industry is represented by large Canadian international airlines such as Canadian Airlines International, Air Canada, and Wardair, and by foreign airlines who operate into Vancouver International Airport. It is also represented by AirBC and Time Air, who provide regional air carrier service throughout British Columbia and Western Canada. Additional representation comes from a large number of unit toll and charter carriers, including helicopter operators and floatplane operators. These smaller operators provide coastal services to small communities, Indian villages, logging camps, and fishing resorts. Canadian Helicopters, the largest helicopter firm in Canada, is also represented in British Columbia.

It is estimated that over 11 million passengers are now being carried. Most of the passenger traffic (75 percent) is enplaned and deplaned at Vancouver International Airport. Victoria, Kelowna, and Prince George are the other main air traffic centres in the province. Transport Canada projects that by 2001, 17.9 million passengers will be enplaned and deplaned through British

Columbia airports. This represents an increase of more than 60%. The growth in air travel activity is based on the same reasons as the growth being experienced in other regions of Canada and the United States.

4.1.1 Commuter Air Carriers

A very dramatic change is the development of the commuter air carrier segment of the air transport industry. A strong commuter network has evolved in British Columbia due to competition between AirBC and Time Air.

AirBC, an Air Canada liaison carrier, was a small coastal air carrier in the early 1980's. It is now carrying over 1.2 million passengers and has annual revenues of nearly $100 million and employs over 1000. AirBC operates a fleet of BAe 146 jet airliners, and DHC-8, DHC-7, DHC-6, and BAe Jetstream 31 turboprop aircraft. It operates throughout British Columbia, Alberta, Yukon Territories, and Washington State.

Time Air, an Alberta based affiliate carrier of Canadian Airlines International, has experienced growth similar to AirBC. It also carried over a million passengers and grossed over $100 million in revenue in 1988. Total employment is 885. The Time Air fleet consists of F28 jet airliners, and DHC-8, DHC-7, Convair 580 and 640, Shorts 360, and Beechcraft 99 turboprop aircraft. Its operation areas include Saskatchewan, Alberta, British Columbia, and Washington State. Time Air has replaced Canadian Airlines International's Boeing 737 jet service on many routes in British Columbia with smaller turboprop aircraft.

4.1.2 Commercial Air Carriers

There are nearly 150 small commercial air service firms in British Columbia which provide unit toll (scheduled) and charter services. Helicopter firms account for about 35 of these commercial operators. Unit toll services are provided by 25 of these carriers. Unit toll carriers serve routes which have a regular volume of traffic to support a scheduled service. Several these unit toll carriers provide important route services to smaller centres from their bases at Vancouver, Prince Rupert, Prince George, Port Hardy, Kamloops, and Williams Lake. Typically small unit toll aircraft operators use Piper Chieftain, Cessna 402, or other similar light twin-engine aircraft. In recent months, however, there is a tendency to purchase larger turboprop aircraft such as the Fairchild Metro and Beechcraft KingAir. These aircraft are pressurized and faster. These are also more sophisticated aircraft in their technology and systems. Maintenance needs are also more complex requiring higher skilled maintenance personnel.

Charter aircraft operators in British Columbia use a wide variety of aircraft types. Aircraft types range from the single engine piston Cessna 150 to the turbofan LearJet and Cessna Citation to the 50 seat turboprop Convair 580. Most of the charter helicopter firms use the turbine Bell 206 type

helicopter. This type accounts for 70 percent of the helicopter fleet in the province. In recent months, however, several larger, twin-engine helicopters have been purchased.

4.1.3 Other Operators

There are about 75 business aircraft operated in British Columbia. Thirty of these are turbofan aircraft like the LearJet, Cessna Citation, Falconjet, Canadair Challenger, and the BAe 125. The principal turboprop aircraft used for business use are the Beechcraft KingAir and Piper Cheyenne, but twin engine piston aircraft are also used for business travel. The majority of business aircraft are based in the Vancouver area. Victoria, Kelowna, Prince George, 108 Mile House, and Kamloops are also bases for business aircraft in the province.

There are nearly 4,500 fixed wing aircraft and 450 helicopters registered in British Columbia. Commercial fixed wing aircraft represent 770 and commercial helicopters some 375 of the total registered aircraft. The remaining 3,800 aircraft are privately registered. Most of the commercial and private aircraft are based at airports in the Greater Vancouver area but there are a number also based in major centres such as Victoria, Prince George, Kelowna, Nanaimo, and Kamloops. These centres, as well as numerous locations in the province, have AME's and other skilled people to service and maintain locally based aircraft, particularly for routine line maintenance needs.

4.1.4 Air Carrier Maintenance

Air Carriers conduct their own aircraft maintenance or contract it to specialized repair and service companies. Large companies, such as Canadian Airlines International and Canadian Helicopters, not only do most of their own aircraft maintenance, but also conduct maintenance on behalf of other air carriers. The range of aircraft maintenance service capability in British Columbia is impressive. British Columbia firms can handle maintenance requirements from the single engine Cessna through to the Boeing 767 and DC-10's operated by Canadian Airlines International.

The specialized repair and service firms in British Columbia target niche markets such as business aircraft, small charter operators, flying clubs, and general aviation. They also concentrate in the areas of maintenance such as avionics, sheet metal, instrument, hydraulics, transmissions, propellers, and engines. Most of these repair and service firms also provide product support for accessory and parts manufacturers. A few are authorized aircraft manufacturer product support centres.

4.1.5 Government Regulations

Government regulations are also influencing aircraft maintenance standards. The Dubin Enquiry into aviation safety in the early 1980's pointed out the relationship between aircraft maintenance and safety and recommended higher standards throughout the aviation industry, including aircraft maintenance. In recent months, aircraft corrosion, aging aircraft, and airworthiness compliance problems have again focused attention on the need for higher maintenance standards. This requires more record keeping and increased responsibility in conducting aircraft maintenance. Transport Canada is addressing maintenance standards. Transport Canada has revised its Airworthiness Manual and AME license qualifications. It has also increased the number of compliance inspectors in all regions of Canada. A tougher interpretation of aircraft maintenance regulations is resulting in additional maintenance hours to meet these standards. Additional trained maintenance people will likely be needed to meet increased maintenance demands despite improved productivity of maintenance departments.

4.1.6 Maintenance Personnel

The air carrier sector in British Columbia is directly linked to the economy. In periods of economic growth, air travel increases; and in economic recessions, air travel is reduced. These cycles have been evident since the industry started in the 1930's. In the 1981-82 recession period, for example, the industry reduced its total employment level by about 20 percent. The reduction in employment also affected aircraft maintenance employees numbers due to reduced flying hours, company bankruptcies, and mergers and acquisitions. Currently the industry is in a boom period and employment is rising.

Layoffs in a recession period, because of seniority and union considerations, affect the youngest employees who are just starting their aircraft maintenance careers. They have some training, but may not have acquired the necessary experience to be a licensed AME. Unfortunately, during the period of re-hire, many of these young people do not return to the air carrier sector. They find that the aviation maintenance skills they have acquired before their layoff are suitable for other industries. The automotive, heavy machinery, heating and ventilating, boat building, forestry, and other industry groups all need skilled people. Many of these other industries also offer job stability, better working conditions, career advancement opportunities, and higher wages. The effect of these cycles has a long term impact on the balance between the supply and demand for skilled labour in the airline industry. Layoffs from previous economic recessions will reduce the stream of trained but inexperienced people from being available when periods of economic growth are regained. Skill shortages can be expected.

Compounding the problem of normal cyclic demand for skilled maintenance people is the current need for well qualified people to maintain new technology aircraft. These indviduals also need to have experience working

with digital electronic equipment, composite materials, and computer controlled aircraft systems. Such people are not often available, even at relatively high wage rates.

There is also the growing problem of experienced maintenance people approaching retirement age. About one third of the AME's are close to retirement age. There are insufficient experienced people being trained to take their positions. Moreover, there are not enough skilled workers to meet the growing need for additional people to meet fleet expansion plans and other opportunities.

Until recent months, air carriers did not concern themselves with skilled labour shortages. In the 1950's and 1960's, the airlines obtained skilled technicians and maintenance engineers from the military. These technicians had completed 5-year short-term military tours. In the late 1960's and 1970's trained people were recruited from Europe, principally the United Kingdom and West Germany. These were skilled journeymen with years of experience in their respective trades. The late 1970's and 1980's saw the major airlines obtaining skilled people from Asian countries, particularly Hong Kong. Additional skilled people could also be attracted to the larger airlines from smaller air carriers with increased wages and fringe benefits such as airline passes. Today the situation has changed. There is a world wide shortage of skilled maintenance people. Trade magazines carry advertisements from airlines around the world. Cathay Pacific Airways, Saudi Arabia Airlines, British Airways, Royal Brunei, Air Lanka, Gulf Aircraft Maintenance Company (GAMCO), and Qantas Airways have all been advertising for maintenance personnel. Some airlines have been offering over $50,000 U.S. a year, tax free, for licensed aircraft mechanics. Along with the money comes housing, transportation, and schooling for dependents. Qantas Airways in particular has been aggressive in the recruitment and have had a recruiting team in Canada. Qantas is 200 workers below desired levels and is looking for 400-600 workers for expanding its capabilities. Qantas Airways is attempting to recruit maintenance personnel from Hong Kong by offering jobs which will ultimately entitle them to Australian citizenship. Qantas expects to have 130 aircraft engineers now working with Hong Kong Aircraft Engineering Co. (HAECO) move to Australia over the next six months. Workers with skills which are short in Australia can gain citizenship and a passport within three years of arriving in the country.[7]

In those countries where Canadian air carriers have successfully recruited in the past, there are significant local opportunities in both the air transportation and aerospace manufacturing. Job stability, career advancement, and high wages in their own countries now make immigrating to Canada less attractive than was the case in previous years. Canadian immigration restrictions on skilled immigrants entering Canada have also increased over the years. Air carriers have to make special applications to Canadian Immigration authorities to have aircraft maintenance people brought

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[7] Flight International, July 15, 1989, p. 4.

into the country. Often, these applications are denied despite being sponsored by a Canadian air carrier. Canadian Airlines International (CAIL), for example, has applications to recruit additional Asian aircraft personnel. CAIL also hopes to recruit skilled technicians from the Middle East who are completing short-term contracts. These potential recruits have United Kingdom Civil Aviation Authority (CAA) or FAA licences. It is, however, doubtful that such applicants will be admitted under present Canadian government policy.

High levels of employment in Eastern Canadian air carrier and aerospace manufacturing also reduce the potential for interprovincial immigration of skilled workers to the British Columbia aerospace industry.

4.2 Aerospace Manufacturing

There are approximately 50 companies which are engaged in direct aerospace activities in British Columbia. Only seven of these aerospace manufacturing companies, however, have annual revenues of more than $3 million. The largest aerospace manufacturer in the province is Canadian Aircraft Products. This company has a gross revenue of $18 million and employs 300 people. Other large British Columbia aerospace companies include Conair Aviation, Canadian Helicopters (engineering division), Innotech Aviation, Ebco Aerospace, and Bendix Avelex. The B.C. Aviation Council estimated that 950 people are directly employed and $80 million in annual sales are generated by these firms.[8]

The capabilities of the British Columbia aerospace manufacturers and repair and service firms are considerable in certain market areas. In the helicopter repair and service areas, for example, Canadian Helicopters, Helicopter Welders, Cam Air, E.M. Heli-Logistics, and Western Airmotive offer strong capabilities to serve not only the British Columbia helicopter market, but also the United States and Pacific Rim countries. Conair Aviation has a world-wide reputation for its design and modifications of aerial fire suppression aircraft. Its Fokker F27 "Fireman" and Grumman Tracker "Firecat" aircraft are designed and modified in British Columbia. Kelowna Flightcraft is developing a similar reputation for modifying and updating transport passenger, cargo, and military aircraft. Ebco Aerospace is capable of 5 axis CNC machining. It is actively conducting sub-contract assignments for Boeing and other major aerospace firms. Canadian Aircraft Products' sheet metal and composite material expertise is reflected in the structures it builds for deHavilland and Canadair. Innotech Aviation has developed unique capabilities to repair and service business aircraft. Bendix Avelex has developed a reputation for competence with fuel control and other instrument systems. Viking Air has developed its unique capabilities to repair older deHavilland products such as the DHC-2 Beaver and DHC-3 Otter. It is now the

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[8] British Columbia Aviation Council - Aerospace Task Force, British Columbia Aerospace Industry Challenge, September, 1987.

world source for remanufactured parts for these aircraft. Northern Airborne Technology is attracting considerable attention for its high technology based avionics products. There are numerous other British Columbia companies which are developing their respective capabilities in the aerospace manufacturing industry and successfully selling their products and services to niche markets.

4.2.1 Industry Problems

The problems and issues associated with the British Columbia aerospace manufacturing industry are related principally to it's relatively small size. The lack of size has been detrimental to market penetration. Smaller companies have difficulties dealing with larger aerospace companies. As noted, each of the British Columbia aerospace companies generates less than $20 million in annual sales. Larger prime aerospace companies are reluctant to provide sub-contracts to smaller companies, particularly if the smaller company is based in a foreign country, like Canada. Small sized companies are perceived by the major aerospace companies to lack the resources to ensure prompt delivery of sub-components. They are also perceived to lack the quality assurance standards and to have higher unit prices due to lower production volume. Accessing some market areas is also difficult for British Columbia aerospace manufacturers due to distance considerations. These market access difficulties can result in higher marketing costs which have to be reflected in product and service prices.

Aerospace manufacturing companies, like the air carriers, are facing an ever increasing shortage of trained people. Most of the skilled people have come from Europe some years ago. Variation in production cycles, like the cycles in the air carrier industry, have affected the supply of trained personnel. To date, there have been few British Columbians trained for the aerospace manufacturing industry. In recent months, there have been structures courses introduced by the training institutes, but sufficient numbers have not been trained to meet the current demand. There are already shortages of individuals trained to work with sheet metal, composite materials, avionics, and precision machines. It is expected the shortage of skilled people will continue.

4.2.2 Industry Linkages

Since the British Columbia aerospace industry is relatively small, it is relying on industry networking to improve its overall capabilities. Linkages between firms are being developed to attract larger markets. Combining capabilities allows the industry to handle larger and larger sub-contracts. It also helps to stabilize the British Columbia aerospace industry by distributing work between the various firms based on their own individual capabilities. It also helps to ease manpower shortages. An example of the networking principal is the Canadian Aircraft Products contract with deHavilland for DHC-8 subassemblies. Canadian Aircraft Products has, in

turn, sub-contracted H&S Tools, CNC Machinery, A&M Metals, and Pacific Avionics for manufacturing components of the subassembly. This allows Canadian Aircraft Products to increase its overall capabilities and to meet delivery commitments to deHavilland.

5.0 AEROSPACE OPPORTUNITIES

The previous three sections presented an overview of aerospace activities around the world, in Canada and in British Columbia. This review presented the aerospace developments which will shape the industry over the next decade. What are the aerospace opportunities for British Columbia, given this background of strong growth forecast in nearly all sectors of the industry and in almost every region of the world? Are there niches which British Columbia's aerospace industry can achieve, particularly those which take advantage of its strategic location in relation to the Asia Pacific region? Does British Columbia have the financial resources, technology base and, most importantly, the skilled labour to become a player in the global network of aerospace activities?

This section discusses possible aerospace opportunities in niche markets which can be developed. These opportunities are happening now or will evolve soon. They are going to take place somewhere due to the continuing demand for the identified aerospace products and services. Aircraft are very mobile and can literally fly anywhere to obtain needed parts or service. Will these opportunities take place in British Columbia?

5.1 Large Aircraft Overhaul and Repair

There are requirements for additional capabilities to overhaul and repair jet airliners. The number of wide body and conventional jet airliners, as noted previously, is forecast to be over 12,000 by the year 2000. While most large airlines can overhaul and repair their own aircraft, there is a move towards contracting the work to firms specialized in third party aircraft maintenance.

Hong Kong Aircraft Engineering Company (HAECO) is one of the better known aircraft overhaul and repair centres. It has just completed a $60 million U.S. four-year upgrade of its maintenance and overhaul facility aimed at increasing efficiency and expanding service capabilities. Its hangar and workshop complex at Hong Kong's Kai Tak airport is now over one million square feet. It can accommodate larger wing-span Boeing 747-400's without crowding out other work. Over the last ten years, the work force of HAECO has tripled to 4,350. Revenue increased 19 percent last year to $154 million. Major maintenance has been performed for Cathay Pacific, British Airways, Flying Tigers, Air Lanka, Royal Nepal Airlines, Bangladesh Bimon, Dragon Air and other Asian airlines. In addition to HAECO, Bedek Aviation of Israel, Lufthansa, Air France, British Caledonia (Ryder), KLM Royal Dutch Airlines, Air Asia (Taiwan), Air Canada and Singapore Engineering are known for their third party maintenance work. G.P.A., the aircraft leasing firm, will establish a centre in Shannon, Ireland. It is also considering a further facility in the Far East. Lufthansa and Air China have announced a joint venture company, AMECO, to develop an aircraft maintenance centre in Beijing. Specific large aircraft overhaul and repair operations are addressed in the following sub-sections.

5.1.1 "C" and "D" Checks

Aircraft require continual inspection. The maintenance checks are based on hours flown, flight cycles and, recently, the age of the aircraft. An "A" check usually occurs at about every 300 - 350 hours of flying. It requires a more intensive check than a daily line inspection. A "B" check occurs about every 1,200 hours and is a more thorough general inspection. However, it is normally completed within a day. Nearly all airlines are capable of performing their own "A" and "B" checks.

Every 12 - 15 months or about once every 3000 - 3500 hours a "C" check is performed. This is an intensive check where all the aircraft's systems are examined and parts or components replaced. Some modifications and repairs will take place, some in response to mandatory Airworthiness Directives (AD) or manufacturer's Service Bulletins (SB). The "C" check can take 12,000 - 15,000 man hours to perform on a wide body aircraft. Several airlines do not have the capability or the resources available to do their own "C" check. Therefore, they send the aircraft to another airline or specialist overhaul and repair firm to conduct the work. A routine "C" check is normally $120,000 U.S. and takes 2 weeks. Where non-routine items are encountered, the cost can increase to $400,000 and take 2 months.

A "D" check is a major overhaul and repair. It requires structural inspection and, where required, replacement of worn sections of the aircraft, resurfacing (de-skinning) the aircraft, and modification and repairs to other parts of the aircraft. A "D" check will occur after 20,000 - 25,000 hours of flying and is performed only 3 or 4 times over the economic life of the aircraft. A "D" check will take between 30,000 to 60,000 man hours to conduct. This time frame is dependent on the size of the aircraft and the amount of structural modifications and repairs needed. The aircraft will be out of service for four to six weeks while the check is being done. Typically, a "D" check will cost an airline $3 - 5 million U.S. Only the largest airlines can conduct a "D" check because of the specialist resources needed. Even those who can conduct a "D" check will send their aircraft out to other firms because of cost and time considerations. Qantas Airlines, for example, is short of its own skilled technicians. It is having its Boeing 747 "D" checks done by United Airlines, Air France, KLM and Singapore Airlines.

In recent months, due to the increasing awareness of corrosion and metal fatigue, new checks are being introduced. One is the Supplementary Structural Inspection Programme (SSIP) or "M" check as called by Japan Airlines. The SSIP is based on the flight cycles of an aircraft and reflects stress due to continual pressurization/depression of an aircraft's hull each time it takes off and lands. A Boeing 727 for example, is inspected every 60,000 cycles; a Boeing 737 every 75,000 cycles; and a Boeing 747 every 20,000 cycles. A SSIP on a Boeing 727 will require about 35,000 man hours of labour. It entails the cleaning, inspecting, modifying and restructuring of the aircraft. Non-destructive testing (NDT) is a major part of the

inspection done for a SSIP. A SSIP check for the Boeing 727 costs about $3 million.

Each airline submits its maintenance schedule to the regulatory authorities for approval. Most submit a progressive type of maintenance plan. Major maintenance is conducted in blocks or modules to minimize the down time of an aircraft. The "D" checks of Aloha Airlines' Boeing 737's, for example, were segregated into 52 steps. It took several years to complete the entire "D" check. Recent incidents have focused on airline maintenance schedules and the need for major maintenance to be conducted more frequently. This will require the aircraft to be out of service for longer periods.

The long range capability of jet airliners places Pacific Rim operators within economical ferry distance for British Columbia. As noted by Kenneth Galpin, Manager of Corporate Planning for HAECO, "When you're talking 12,000 - 15,000 man hours on a major aircraft overhaul, it does not matter where in the world the maintenance hangar is".[9] British Columbia could be the base of that aircraft overhaul and repair being located at the crossroad between Europe and Asia.

5.1.2 Aging Aircraft

The aging aircraft issue presents a major challenge to the aerospace industry. Over the last 18 months, the world's airlines have been galvanized on the effect of aircraft fatigue and corrosion on a jet airliner's structure. The problem is affected by several factors such as hours flown, flight cycles, operation environment and age of the aircraft. Aging aircraft can have their skins, spars and ribs renewed indefinitely. Corrosion from neglect, however, can hasten the aging process.

Electro-chemical action causes corrosion on metal surfaces and structures. Acids, salts or alkalis found in contaminated air and moisture will develop a chemical reaction with aircraft metal. Corrosion commonly occurs in aircraft galleys and lavatories from spilled chemicals (alcohol, coffee, etc.) seeping under the floor. Engines, nacelles, the undercarriage, moving wing surfaces and other areas where stress can occur are areas where corrosion as a result of humidity and salt water can be damaging. There are several types of corrosion, but dry oxidation is very common. Corrosion, if not corrected, erodes the metal surface, weakening its intrinsic structural strength. If fatigue is also present from bending and stretching the metal, the metal deterioration increases to the point of damage.

Soon after the Aloha airlines incident in August, 1988, an Airworthiness Assurance Task Force was formed with representatives of the aircraft manufacturers, airlines and the FAA to address the problem of aging aircraft

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[9]Proctor, Paul, "HAECO Upgrades Maintenance Facility, Employee Benefits", Aviation Week & Space Technology, June 12/89

and corrosion damage. Service Bulletins (SB) announced by the Boeing Task Force in March, 1989 covered such items as lapjoints, belly and crown skins, and reframing and re-skinning. In May, the FAA mandated these modifications in an Airworthiness Directive covering 115 U.S.-registered Boeing 727, 737 and 747 aircraft. These aircraft must be fixed over the next four years at an estimated cost of $142 million U.S. to the operators. These actions have been endorsed by the European Joint Airworthiness Authority (JAA) and other airworthiness authorities. The Boeing Task Force still has to complete its work on the Boeing 707, more than 200 of which are still flying.

The Douglas Task Force will report later on DC-8's, DC-9's and DC-10's. A third working group is assessing the Lockheed L1011's, Airbus A300's, BAe 1-11's and Fokker F28's.

The world's jet aircraft fleet indicates that nearly 2,500 aircraft are more than 20 years old. These older aircraft represent more than 30 percent of the total. The average age of the entire fleet is now 11.7 years. This figure is expected to increase to nearly 14 years by the year 2000 despite the number of new aircraft entering service in the 1990's. It is estimated that $800 million will be required for the necessary inspections and repairs for the world jet transport fleet to continue to fly throughout the 1990's.

Table G, overleaf, shows the older aircraft in the world fleet. The DC-9 is the most numerous of the older aircraft, followed by the Boeing 727.

Aging aircraft modifications are expected to require additional skilled manpower to carry out the additional inspections, repairs and modifications which will be required. Northwest Airlines, for example, has hired an additional 600 maintenance personnel needed for the additional work. Table H shows expected airframe maintenance requirements for the world jet transport fleet and the additional personnel needed due to aging aircraft.

Table G

AGE OF WORLD FLEET

	AGE 15+	AGE 20+*	AGE 25+*
AEROSPATIALE			
Caravelle	43	30	22
BOEING			
707/720	235	178	43
727	765	525	166
737	348	238	-
747	228	95	-
BRITISH AEROSPACE			
BAC 1-11	132	128	22
DOUGLAS			
DC-8	227	215	19
DC-9	923	702	6
DC-10	238	3	-
FOKKER			
F28	73	24	-
LOCKHEED			
L-1011	117	-	-
TOTAL	3,329	2,138	278

* aircraft included in previous columns

Source: Flight International, July 15, 1989

Table H

AIRFRAME MAINTENANCE REQUIREMENTS
WORLD JET TRANSPORT FLEET

	NORMAL PERIOD SERVICE		AGING AIRCRAFT SERVICE	
	Annual Maintenance 000.000 hours	Man Years No.	Annual Maintenance 000,000 hours	Man Years No.
1988	85.9	49,075	3.1	7,780
1990	99.1	56,625	21.9	12,515
1995	126.1	72,055	21.9	12,515
2000	164.0	93,745	25.0	14,255

Source: Aviation Week & Space Technology, July 24, 1989

Many of the airlines do not have the in-house resources to conduct the inspections and repairs to their aging fleets. Modification centres are positioning their operations to meet an anticipated massive workload from the airlines. American Airlines, for example, has just contracted DynAir Tech of Phoenix, Arizona to inspect 65 of their Boeing 727's. It has completed the required inspections on 18 Boeing 737's. These modification centres, however, are experiencing shortages of facilities and trained personnel. Difficulty in obtaining the necessary parts is a problem because the airframe manufacturers' production lines are already moving at record rates. According to Clyde R. Kizer, Vice President Engineering and Maintenance of the Air Transport Association, "The biggest constraint in the industry is the people to do the work and the space to do it in ... You have to have the large hangars and the people."[10] The resources of the airline maintenance departments are fully committed to routine maintenance and inspections. Few airlines are prepared to handle the additional structural requirements emerging for high-time aircraft. The anticipated shortage of trained mechanics and the lack of capacity to handle the aircraft requiring

[10] Growing Aircraft Maintenance Needs Press U.S. Repair and Modification Capacity, Aviation Week & Space Technology, July 24, 1989

inspection and repairs have prompted the major modification firms to make significant capital investments to obtain additional people and to expand their facilities and resources for aging aircraft work. Several companies are starting in-house training programmes and expanding facilities. Others are locating new repair stations in areas where skilled labour aerospace labour exists and are building new facilities.

Aging aircraft modifications could be done in British Columbia as part of a large aircraft overhaul and repair centre. The opportunity now exists for hundreds of older aircraft to be inspected and repaired. These could be attracted to British Columbia if the skilled personnel and facilities are available.

5.1.3 Boeing 747 Section 41 Modifications

In 1984, operators of high cycle Boeing 747's detected substantial cracking in Section 41, the forward fuselage area (Figure 9). Cracks appeared in the stringers and external skin. In 1986, Boeing issued a service bulletin of recommended internal fuselage inspections and the FAA issued airworthiness directives requiring both internal and external inspections. The recommended inspections are carried out by visual, boroscope, and x-ray inspection techniques. Table I shows the service bulletin inspection schedule.

Table I

SECTION 41 INSPECTION SCHEDULE
513 747-53a 2265

CYCLES (HOURS)	MAN HOURS	ELAPSED TIME
8,000	66	33
10,000	1,260	273
13,000	1,510	335
16,000	2,830	376
19,000	3,612	445

Source: Forseth, Paul, "Modification and Repair of Section 41 of High Cycle 747's", Boeing Commercial Airplane Company New Developments in Aircraft Maintenance Engineering - Asian Aerospace 88, Singapore, January 28, 29/1988

BOEING 747

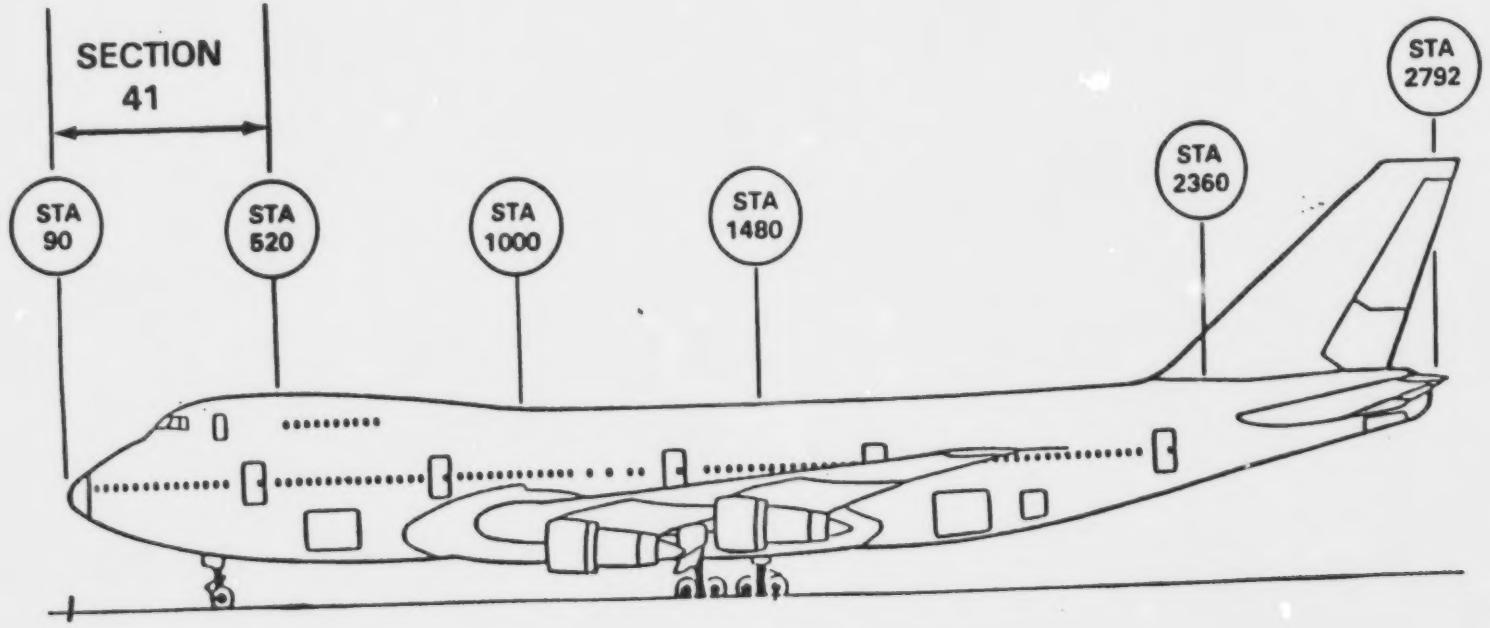

Figure 9

There are over 640 active Boeing 747's which have to be inspected, nearly 400 have over 8,000 cycles.

Boeing has redesigned Section 41 to improve the fatigue quality. The design increases the gauge of the materials used and the design of the frames, selected skins, entry door sill/frames and selected floor beams. These redesign features were incorporated in the production line with aircraft number 686 in August, 1987.

Modifications will have to be conducted on all previous Boeing 747's to reflect these design changes. Section 41 modifications are carried out in 9 modification zones (Figure 10). Table J, overleaf, shows the manpower estimate to conduct the modifications.

There are few airlines or modification centres which have the facilities and resources to conduct third party Section 41 modification. Several airlines which can carry out Section 41 modifications do not have the available manpower resources. The following have the capability:

- Singapore Airlines, Singapore
- United Airlines, California
- Evergreen Air Centre, Oregon
- Hong Kong Aircraft Engineering Co. Ltd.
- Marshall of Cambridge, England
- Israel Aircraft Industries, Israel (Bedek Division)
- Dalfort Aviation Services, Texas/Arizona
- Lockheed, Georgia

There is an opportunity for a major aircraft overhaul and repair centre in British Columbia to offer Section 41 modification capability. There is a shortage of Boeing 747 capacity. Operators of this aircraft will likely elect to carry out the Section 41 modifications to maintain the aircraft's value.

5.1.4 Mandatory Installation

There are several mandatory items which will have to be installed in aircraft in the future. Regulatory authorities have issued notice that certain equipment will be compulsory on large transport category aircraft.

Flight Data Recorders (FDR's) which can record a minimum of 17 aircraft operating parameters is one mandatory item. FDR's will have to be installed on aircraft which are not equipped with these recorders or that have older "foil-type" recorders. Aircraft will also have to be equipped with cockpit voice recorders (CVR's). The mandatory installation of Flight Data Recorders and Cockpit Voice Recorders will affect many aircraft. Those affected are

older aircraft which were not equipped with these devices when manufactured. These devices are to be installed by October, 1991.

Table J

SECTION 41 MODIFICATION
MANPOWER ESTIMATE/AIRCRAFT

ZONE NUMBER	MAN HOURS	ELAPSED TIME (HOURS)
1	5,358	530
2	3,576	459
3	4,144	523
4	3,080	400
5	1,578	264
6	4,420	449
7	2,684	350
8	472	216
9	2,776	379
	28,088	3,570

Source: Forseth, Paul, op. cit

The FAA has notified operators that in January, 1991 windshear detection equipment has to be installed in all Part 121 transport category aircraft operating in the U.S. Windshear warning equipment will allow the detection of a microburst of wind change during the approach or take-off of an aircraft.

In 1992, Traffic Collision Avoidance Systems (TCAS) will have to be installed in some 3,800 Part 135 aircraft which operate in the U.S. It is expected that it will cost aircraft operators nearly $600 million to install the TCAS equipment in the U.S. fleet.

Regulatory authorities will require other mandatory equipment installations or modifications to improve safety. To install these devices, the aircraft has to be removed from service for about 5 - 10 days for each installation. The cost to install will vary between $30,000 U.S. to over $125,000 U.S. An aircraft overhaul and repair centre which can offer the installation of these mandatory devices while other work on the aircraft is being done has an advantage over other competing modification centres.

SECTION 41 MODIFICATION

MODIFICATION ZONES

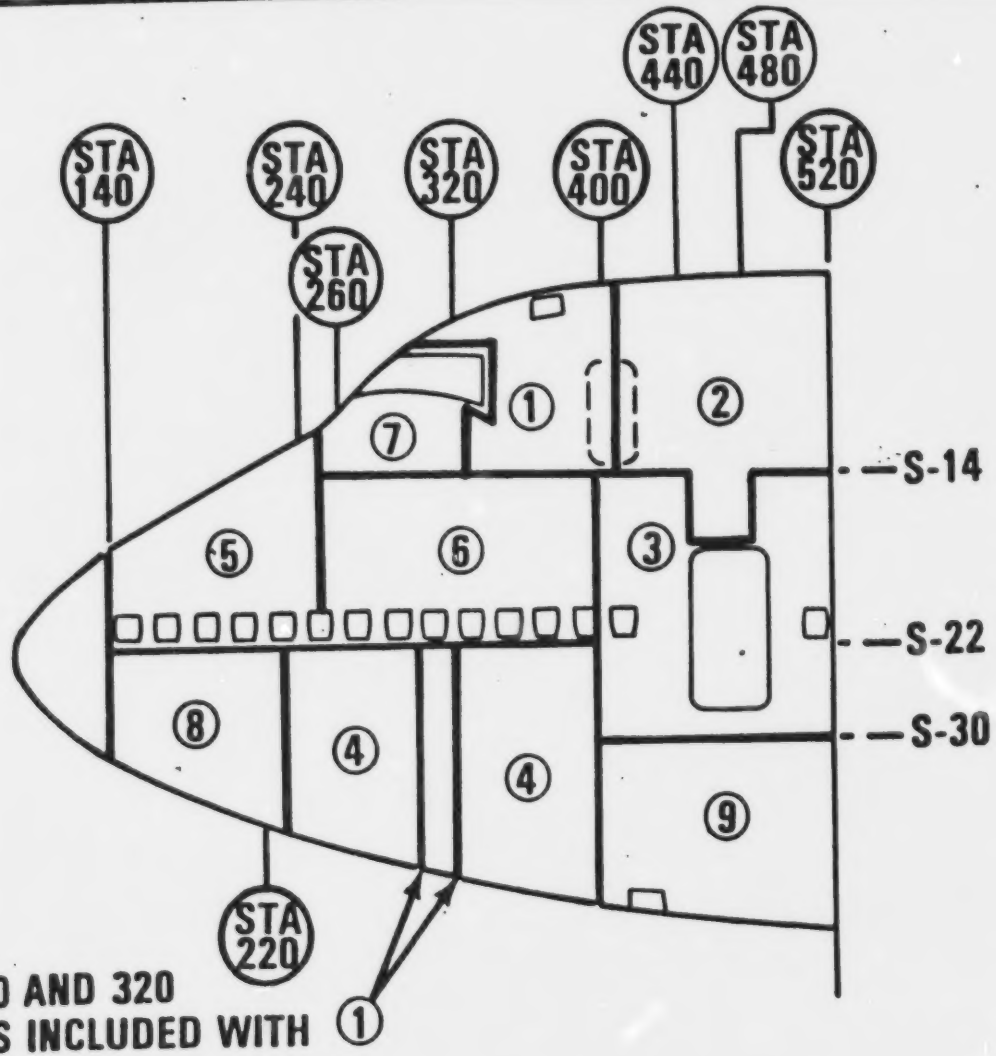

Figure 10

5.1.5 Cargo Conversions

The increased demand for air cargo has seen a corresponding demand for air cargo or combination (Combi) aircraft. Many earlier DC-8's and Boeing 707's have been re-engined and converted to cargo aircraft. The L-1011 is also becoming a popular freight aircraft after conversion from a passenger configuration.

The Boeing 747 is becoming one of the best air cargo aircraft due to its huge cargo carrying capability and range. There are some 80 Boeing 747 freighters in operation. The largest operator is Flying Tiger with 21 freighters. Boeing is currently not producing new Boeing 747 freighters due to the backlog for Boeing 747-400 passenger and combination aircraft. The company will not have a Boeing 747-400 freighter available until 1994. In the meantime, the value of used Boeing 747 freighters has appreciated. Older Boeing 747-100 models have a higher value if converted to a freighter version. It is estimated that the freighter is $11 million more valuable than the passenger version. Several of the airlines which operate 100 series passenger aircraft, such as United Parcel Service, Evergreen and Japan Air Lines, are considering converting these into freighters. Pan American, which has 37 Boeing 747-100's, will convert 19 of these into freighters.

The conversion requires strengthening the floor, installing a cargo door and fitting a cargo interior in the aircraft. The cargo conversions are done at Boeing's Wichita, Kansas facility or by Bedek Industries in Israel.

As the cargo version of the Boeing 747 increases in value, there will be more earlier Boeing 747 passenger aircraft converted to freighters to meet the demand. The Boeing Company predicts the market for wide-bodied freighters will double to 300 aircraft by 1999. New aircraft will not be available to meet this demand, therefore older passenger aircraft will have to be converted.

Boeing will be able to convert only four to five aircraft per year. The price of the conversion is about $18 million per aircraft, and the work will take three to four months. A newer Boeing 747-200F, in comparison, costs about $125 million U.S.

Conversion of wide-bodied passenger aircraft into cargo or combination aircraft could be done in a British Columbia aircraft overhaul and repair centre. There is currently limited competition to conduct conversions of wide-bodied aircraft. Additional capacity will be added with the expected demand for the booming Asia Pacific air cargo trade.

5.2 Engine Overhaul and Repair

There are opportunities for British Columbia to undertake the overhaul and repair of turbine engines. There are opportunities to overhaul and repair high thrust bypass turbofan engines used in commercial jet transports. Smaller jet engines used in business aircraft, turboprop engines used in commuter aircraft and turboshaft engines used in helicopters also present overhaul and repair service opportunities. Each engine type, however, requires its own facilities and expertise.

There is some turbine engine overhaul expertise now in British Columbia. Canadian Airlines International does overhaul its Pratt & Whitney JT8 series and General Electric CF6 series jet engines. However, it is limited in the scope of repairs it can conduct. It also has an engine test cell. Canadian Helicopters has the authority to overhaul Allison, Rolls Royce, Pratt & Whitney Twin Pac, and General Electric turboshaft engines used in the helicopter fleet. The company recently announced an $11.7 million expansion of its facilities at Vancouver International Airport which will accommodate its relocated engine shop. Canadian Helicopters also has an engine test cell. Innotech Aviation is an authorized service centre for Garrett turboprop TPE 331 and turbofan TFE 731 engines as well as the Pratt & Whitney JD-15 turbofan. Innotech Aviation plans to expand its engine overhaul capabilities for the Garrett engines. Western Airmotive, a new company, can overhaul the Allison 250 turboshaft helicopter engine. In addition, there are firms such as AR Technologies, which can conduct specialized services such as turbine blade replating. While the existing scope of engine overhaul and repair services is good, there are several opportunities where British Columbia's engine overhaul and services could be expanded to serve a widening Asia Pacific market. These engine overhaul opportunities are discussed in the following paragraphs.

5.2.1 Large Turbofan Engines

There is an opportunity for a medium size (i.e. 100,000 sq. ft. plus), large jet engine overhaul and repair centre in British Columbia. About 250 skilled people are needed for a medium sized engine facility handling up to 100 engines a year on a production line type of basis. A new high thrust bypass engine which has a capital cost of up to $5 million U.S. will cost $600,000 - $800,000 U.S. for the first overhaul. Later overhauls will be even costlier as additional parts have to be replaced instead of being overhauled and repaired.

In the last few years, General Electric and CFM International (General Electric and SNECMA joint venture) have captured 60 percent of the large jet engine market. There are over 2000 CF6-50 engines (46,000 - 54,000 lbs. thrust) in use in DC-10's, Boeing 747's, and Airbus 300 series aircraft. There are over 1100 of the higher and newer thrust CF6-80 engine (48,000 - 66,000 lbs. thrust) series in service on Airbus A310, Boeing 767, and Airbus A300-600 aircraft. This engine will also be installed in the new Boeing 747-

400 and the MD-11 aircraft. Some 260 CF6-80 engines were produced in 1988 and 330 are planned to be shipped in 1989. There are over 800 orders for additional CF6-80 engines to power new aircraft deliveries.

The smaller thrust (20,000 - 31,200 lbs) CFM-56 series is experiencing remarkable market success. This engine was first certified in 1982 and over 3,100 have been delivered. Over 1,300 have been delivered in the last two years. There are orders for a total of 6,500 CFM-56 engines. Current production is 60 per month and this rate will increase to 100 per month in 1992-94. The CFM-56 powers the Airbus A320, Boeing 737-300, Boeing 737-400, Boeing 737-500 and conversions of the Boeing 707 and DC-8. The new Airbus A330 and A340 will also be powered by CFM-56 engines.

There are currently few engine overhaul and repair firms which can offer full service overhaul and repair for these engine types. It is expected, however, that due to the popularity of these engines in many of the world's aircraft, additional overhaul capacity will be added. There is an opportunity for British Columbia to capture a significant share of the market due to the capability void which currently exists. United Airlines in San Francisco, American Airlines in Tulsa, MTU Maintenance GmbH in Germany, British Caledonia (Ryder) in Prestwick, General Electric in Evendale, Ohio and Ontario, California, Sochata SNECMA in France have the expertise in these engine types to service third party airlines.

An engine overhaul and repair facility in British Columbia could have significant sub-contract opportunities for smaller British Columbia firms. About 20 - 30 percent of the overhaul can be sub-contracted. Sub-contracting opportunities exist for machining, specialized welding, replating, blade repair, accessories repair and other lower volume activities which are necessary to support a complete engine shop. Sub-contracting allows the engine overhaul and repair centre to process engine overhauls on a production line basis.

5.2.2 Smaller Turbine Engines

There is some capability to overhaul smaller turbine engines in British Columbia. The newly announced engine shop facilities of Canadian Helicopters, for example, will offer increased capability for Allison turboshaft engines. There are opportunities to increase the overhaul and repair capability to increase the work done in British Columbia on Pratt & Whitney and Garrett turboprop aircraft. The Pratt & Whitney of Canada PT-6 series and 100 series of engines power many commuter aircraft including the deHavilland aircraft used by British Columbia commuter airlines. Over 30,000 Pratt & Whitney engines have been produced since 1954. The Garrett engine is similarly used in the Fairchild Metro and the British Aerospace Jetstream 31 used in British Columbia. Capability could be added to the firms which now offer partial overhaul service. These firms could then conduct more of the overhaul and repair services in British Columbia rather than sending engines to the U.S. and Eastern Canada.

As with the larger engines, there are also opportunities for sub-contracting specialized tasks to smaller British Columbia firms.

5.3 Modification Centres

Aircraft modifications offer an opportunity to British Columbia aerospace firms. Modifications now take place at several firms. There are opportunities to expand current business and to start new ventures.

Conair Aviation has an established reputation to convert and modify aircraft into specialized forest fire protection aircraft. It converts F27 turbine passenger aircraft into the "Fireman" capable of dropping fire retardant from its computerized drop doors. Conair also converts the Grumman "Tracker" into the "Firecat" bomber. It recently developed a PT-6 turbine conversion for this aircraft. The company also has developed specialized tanks for helicopter installations and other devices to aid in the detection and suppression of forest fires.

Innotech Aviation, at its Vancouver International Airport facility, is noted for its services to business aircraft. It is proposing to expand its aircraft refurbishing business by offering cabin interior, exterior painting, avionics up-grading, engine overhaul, and aircraft maintenance services.

Kelowna Flightcraft is capable of installing cargo doors on the Convair aircraft and is proposing to offer a Stretched Convair with turbine engines in the future. The company recently completed a DND contract to update the avionics of seven Cosmopolitan CC-117 aircraft.

Canadian Helicopters offer several helicopter modifications including an Emergency Medical Service (EMS) cabin interiors for the Sikorsky S-76 helicopter. The EMS version has emergency stretchers, attendant seats and equipment needed for trauma patients.

There are several opportunities which the existing modifications centres or new modification centres could offer.

5.3.1 Noise Suppression

Current regulations in most countries require that aircraft meet ICAO Annex 36, Chapter II (FAA Stage II) standards. It is anticipated that many, including most European nations and North America, could enforce higher Chapter III standards in the late 1990's. It is estimated that 70 percent of the North American and European airline fleet - about 3,550 aircraft - do not meet Chapter III noise requirements. Replacing these aircraft with quieter Chapter III transports could cost $75 billion. Several programmes are available to re-engine, hush kit or otherwise quiet transport aircraft which will continue to have an economic life beyond the year 2000.

There is an opportunity for modification centres in British Columbia to offer services to modify existing aircraft to Chapter III noise standards. Aircraft such as the Boeing 737-200 (1400), DC-9 (850), BAe 1-11 (160), F28 (200) and Boeing 727 (1,650) do not meet Chapter III noise standards. Hush kits are available for the Boeing 727 and are being developed for the DC-9 and Boeing 737-200. Hush Kits cost between $500,000 and $2.5 million U.S. to install. They also require that the aircraft be out of service for several days. Re-engining is becoming popular since the replacement turbines not only meet Chapter III noise standards, but are more fuel efficient than the original engines. The Rolls Royce Tay 600 series engine is used in re-engined BAe 1-11 and is available to repower DC-9, Boeing 727 and Boeing 737 aircraft. Pratt & Whitney is evaluating its JT8D-200 series for re-engining applications. Re-engining would require a minimum of $3 million U.S. to install a new 15,000 - 20,000 lb. thrust engine ($7 million U.S. for a Boeing 737). The process would require 8 - 10 weeks to complete.

5.3.2 Turbine Conversions

There are also opportunities related to turbine conversions. There are piston powered transport aircraft, such as the Convair, which can be converted to turboprop engines to provide increased efficiency over the original powerplant. There are still over 100 piston Convairs in operation. There are also turbine conversions for utility aircraft such as the Cessna 337 and Cessna 206 or for early Sikorsky S-55 and S-58 helicopters. There are also some older turbine aircraft which could be converted to later model turboprop or turbofan engines. The FalconJet 20 and earlier BAe 125 models are being repowered with later technology engines.

5.3.3 Cargo Conversions

There are many smaller transport and utility aircraft which are suitable for conversion into cargo aircraft. The demand for courier services has prompted interest in converting former passenger aircraft into freighters or combination aircraft. Convairs, Lockheed Electras, early model DC-9's and Boeing 737 and 727's are being converted to meet the demand for suitable aircraft. British Columbia firms can carry out these cargo conversions.

5.3.4 Long Range Fuel Tanks

Modification centres indicate a demand to install additional fuel tanks in aircraft to increase the aircraft's range. Several DC-10 and Lockheed 1011's have additional fuel tanks to increase their capability to operate on non-stop international routes. There is a similar demand for other transport category and business aircraft to fly longer distances. British Columbia firms have the expertise to build and install these fuel tanks in a variety of aircraft.

These modification centre opportunities also have linkages to smaller subcontracting firms in the province. There will be a requirement for sheet metal and composites work, machining, electrical and other systems installation work, and avionics installations. To do this work, the modification centres will need assistance.

5.4 Aerospace Structures

Currently, Canadian Aircraft Products and Ebco Aerospace are suppliers of aerospace structure components to the major airline manufacturers. All the major airframe manufacturers are producing record numbers of aircraft. The number of orders and backlog have generated production problems with the major manufacturers. They are relying on sub-contractors to take an increasing share of the work to meet schedule commitments to the airlines. Manufacturers are increasing their production schedules to meet the demand.

McDonnell Douglas has a backlog of $18 billion on over 400 firm orders for the MD-80. Another 525 options mean that the backlog issufficient to keep the production line full until the year 2000. The new MD-11 will soon fly and the company has orders for 95 and options for a further 220. McDonnell Douglas reports that it is handicapped by inexperienced workers who require costly training programmes. It cannot build enough of its own parts to meet production needs, and outside suppliers cannot keep pace with received orders.[11] McDonnell Douglas has increased the market production of MD-80 aircraft to nearly 11 a month. The MD-11 will be produced at a rate of 4 per month when in production in the 1990's.

Boeing Commercial Airplane is also experiencing serious problems of meeting the demand for new transport aircraft. Currently, there are $80 billion in back orders for new aircraft. Production delays and quality control problems are being experienced. Boeing Chairman Frank Shrontz noted "a serious workforce dilution problem."[12] Some 60 percent of the workers have less than two years of experience. Boeing sub-contractors supplying components are equally stretched to meet production time tables. The company now has a backlog of over 1,600 aircraft. It plans to increase it's monthly production from 20 to 42 aircraft in the early 1990's. This increased production schedule relies on increasing sub-contractor parts supplies from 30,000 a month in 1989 to 140,000 a month in the 1990's.[13] This will require an increased number of outside suppliers to meet these production quotas.

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[11]Henkof Ronald, "Bumpy Flight at McDonnell Douglas", Fortune, August 28/89

[12]Schreiner, John, "Boeing - Upside has its Downside", The Financial Post, August 21, 1989

[13]Blakely, R. W., Boeing Commercial Airplane Company, presentation on Boeing procurement opportunities, Vancouver, BC - August 14, 1989

Not only are the major manufacturers facing production problems. In Canada, deHavilland has a backlog for 160 commuter airplanes worth nearly $2 billion. Currently production is 5 aircraft a month and the company wants to increase the rate to 7 a month. Canadair is achieving record marketing results. It has built over 180 Challenger business jets and plans to build 2 a month for the next several years. In addition, it has 120 orders for its new Regional Jet (RJ) designed for the commuter market. Canadair also has many sub-contracts from Aerospatiale and British Aerospace for the Airbus A330/A340 as well as continuing work from Boeing and McDonnell Douglas.

There are opportunities for British Columbia aerospace to be direct suppliers to the major manufacturers. There is also opportunity to work with the principal sub-contractors who are experiencing difficulty meeting production schedules.

5.4.1 Extensions of Existing Sub-contracts

Canadian Aircraft Products has recently been awarded a contract for a further 100 deHavilland DHC-8 stabilizers. This extends sub-contract work for only another 14 - 15 months. DeHavilland is seeking new five-year, fixed-price contracts and will be requesting international firms to bid on the new contract. Canadian Aircraft Products, due to their experience with the work, should be a strong competitor. DeHavilland is also considering a new DHC-8-400 stretched aircraft. There are opportunities to develop a risk-sharing proposal with DeHavilland to ensure this work will be done in British Columbia. Finally, Canadian Aircraft Products does the tail stabilizer on the Challenger and should be in a good position to obtain a similar contract for the new RJ.

5.4.2 Aircraft Components

British Columbia aerospace firms can develop larger aerospace components on their own or with other international aerospace firms.

Aerospace Technologies of Australia Pty Limited (ASTA) is a possible role model for British Columbia aerospace firms. In 1987, Government Aircraft Factories (GAF), which was a small domestic oriented company, was re-organized and renamed with a mandate to obtain international commercial contracts. It has developed into a major diversified aerospace company performing various civil and defense projects. It also acquired new technologies and a full range of applications related to them. Some of these initiatives include a joint venture with British Petroleum to manufacture and fabricate, in Australia, advanced composite products. An agreement has been signed with Aerospatiale and China Aero Technology Import & Export Corp. (CATIC) to develop a new generation light helicopter. ASTA has become a risk-sharing partner with Aerospatiale in the production of Airbus A330 and A340 transports including landing gear doors and floor support components. Current ASTA projects include:

- component manufacture and final assembly of F-18's
- the manufacture, under license, of Pilatus PC-9 Trainers
- the manufacture of Boeing 747 flaps
- the manufacture of Boeing 737 inspar ribs
- the manufacture of Sikorsky rotor components
- the manufacture, for British Aerospace, of Airbus A320 fixed shroud
- the production of chemical milling for doors and profile spars for the MD-80

ASTA's achievement shows the results of a strategic plan which has been acted upon.

British Columbia aerospace firms could handle several fuselage, wing and tail components for assembly, particularly those parts requiring sheet metal and composite manufacturing and machine processing. Cabin galleys have been identified as an area in which there are supply problems which are delaying completion of aircraft. These could be made in British Columbia. Most of the sub-contracts, however, require risk-sharing capital to develop the various component prototypes and the specialized tooling. The payback period can take several years and requires some type of government support. With this support, smaller aerospace firms can negotiate such contracts with major aerospace firms.

5.4.3 Parts Manufacture

There is a growing market to manufacture aircraft parts for older aircraft. As aircraft age, the demand for parts increases. The major airframe manufacturers normally manufacture their own spare parts and make sufficient parts to last several years. The manufacturers, however, did not anticipate that many of the early jet transport aircraft would still be operational some 20 or 25 years after production ended. It is becoming increasingly difficult for the major parts manufacturers to build replacement parts for the Boeing 707, Boeing 720, Boeing 737, Boeing 727, Douglas DC-8 and DC-9 due to their own production line capacity problems. Suppliers also are finding it difficult to provide parts both for production and operating aircraft. There are opportunities for British Columbia companies to provide these needed parts for aging aircraft. There also may be opportunities to re-manufacture and repair those parts which are not time-limited or subject to fatigue.

6.0 SURVEY OF B.C. AEROSPACE FIRMS

A comprehensive survey of British Columbia aerospace firms has been conducted for this study. It includes several of the larger Canadian airline companies who have a major presence in the province of B.C. All firms affiliated with the British Columbia aerospace community, approximately 220, were contacted and requested to complete a questionnaire. Data expressed in this study represent replies from 80 companies. These companies include all of the major air carriers and aerospace manufacturers operating in the province.

The following information was obtained during the industry survey:

- Number of employees by workforce category.
- Number of employees by category expected over the next 5 years.
- Skills now required and anticipated changes in skill needs over the next 5 years.
- Difficulties experienced in obtaining skilled workers.
- Current and expected management, engineer, technician, and apprentice levels of employment.
- Non-union/union representation.
- Unions represented (e.g. International Association of Machinists and Aerospace Workers, etc.).
- Wage rate/benefits paid by experience level.
- Hiring practices (B.C., Canada, foreign recruitment).
- In-house training availability (classroom instruction).
- On-the-job training/learner programme availability.
- Use of structured, outside training centres.
- Licensed employees by category (e.g. AME - A, R, E, B, D, P categories and type endorsements).

The questionnaire was tested by different Vancouver area aerospace companies before being mailed to the other companies in the province. Stamped, self-addressed envelopes and telephone follow-up techniques were used to assist the response rate of returned questionnaires. In addition, the major firms were personally interviewed to obtain additional comments and viewpoints on skilled worker requirements.

6.1 Profile of Workforce

Based on the information obtained from the industry survey, a profile of the British Columbia aerospace labour force has been developed for 1988. The following subsection presents the highlights of the profile.

The industry survey accounted for some 11,490 employees in the aerospace industry. The major and regional airlines, Air Canada, Canadian Airlines International, Wardair, AirBC and Time Air responded with their total maintenance division employees working in the system. A closer examination

of allocating skilled employees of these large employers only to those which reside in British Columbia, reduces the total to about 3,663. It is this lower figure which is used as a data base for the British Columbia skilled aerospace labour forecast developed in a later section.

1) Type of Aerospace Business

Figure 11 shows the type of aerospace business in which the various respondents are engaged. The repair and overhaul category represents the largest. The air carrier category ranked second in the number of responses.

2) Annual Sales Volume

Figure 12 shows the annual sales volume of the British Columbia aerospace industry. The figure shows that the majority of the firms report sales between $1.0 - $5.0 million, followed by sales of under $500,000.

3) Business Conducted in British Columbia

Most of the respondents reported that 76-99 percent of their business was conducted in the province. The major airlines and the larger aerospace companies report a higher percentage of their business conducted out of British Columbia.

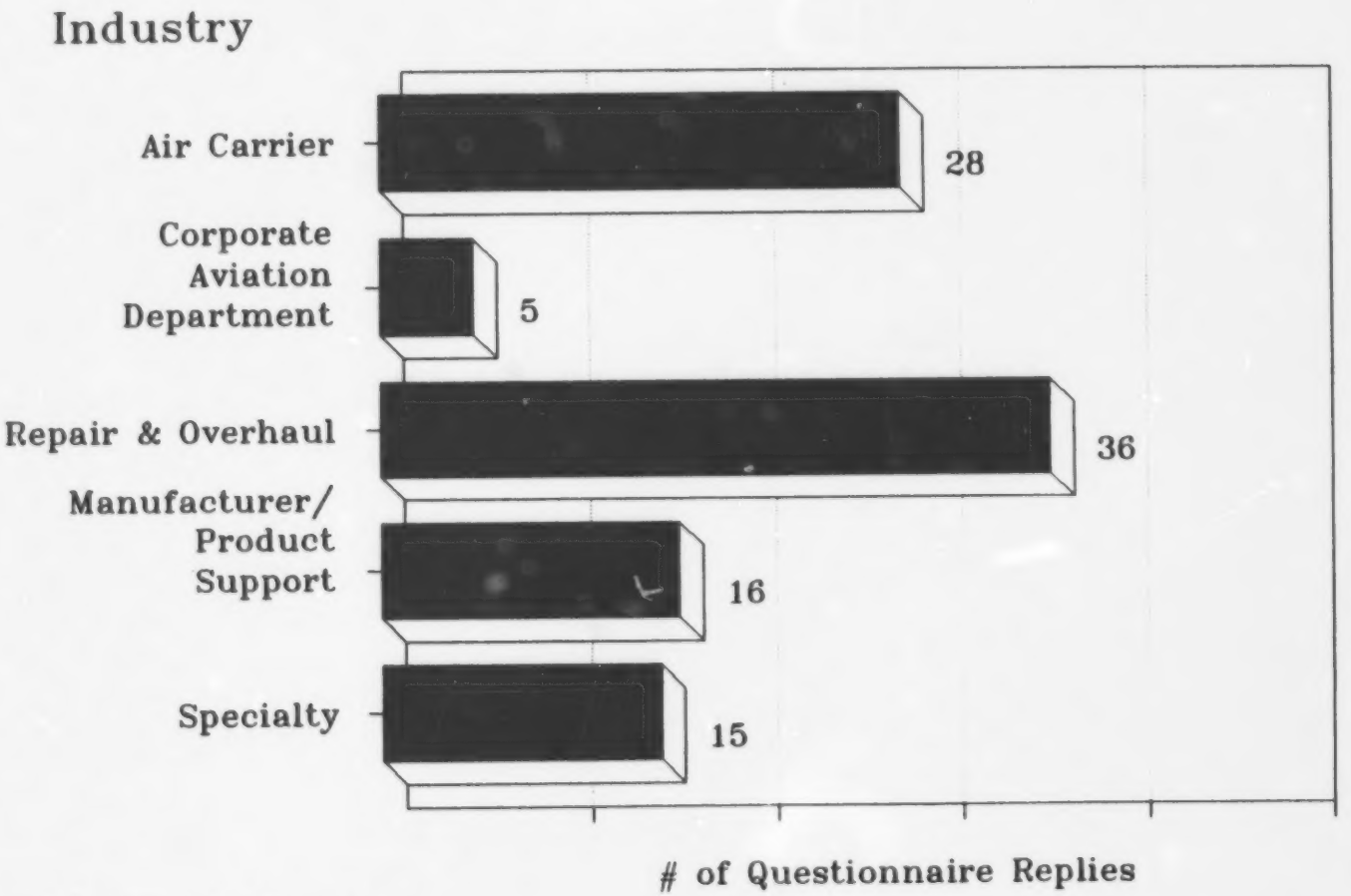
4) Specialized Services or Products

Some respondents noted that they specialized in certain services or products. This indicates that niche markets are important to the industry.

5) Sub-Contract Work

Some 38 percent of the aircraft operators (including scheduled, charter, corporate, flying schools) contract all their maintenance to repair and service firms. Some 77 percent indicate that they sub-contract some of their aircraft maintenance and/or aerospace manufacturing to others. This indicates that the industry is highly dependent on others for certain maintenance of their aircraft or producing their aerospace products. Linkages are important in the aerospace industry.

Aerospace Industry Profile

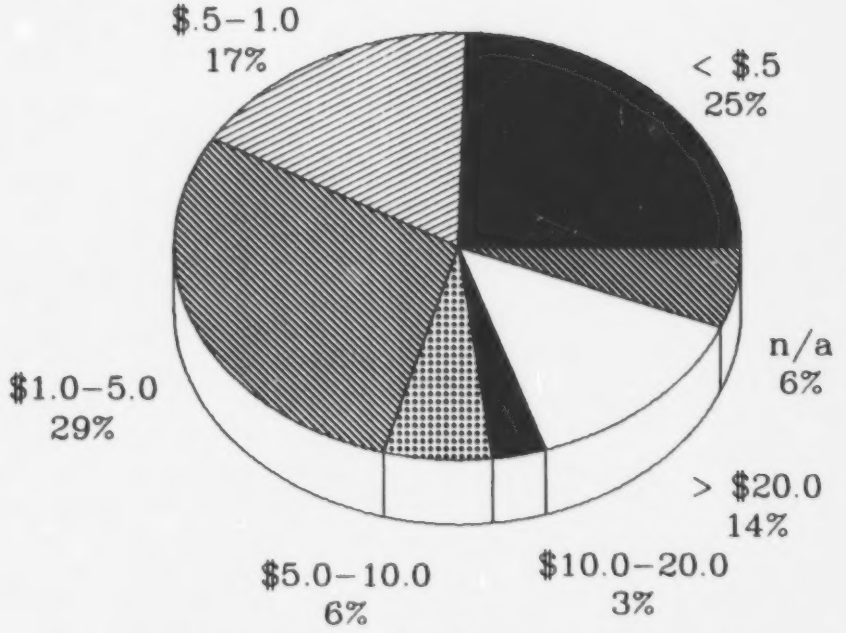


McNeal & Associates Survey
May 1989

Note: Respondents may fall into more than one category

Figure 11

BC Aerospace Labour Study
Annual Sales Volumes



Annual Sales Volume ($ million)

McNeal & Associates Survey
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Figure 12

6) Trades and Technical Employees

The industry survey requested a listing of trade and technical people by category, both permanent and part time, by their companies in 1988. The companies were also asked to estimate employment by the same categories for 1995. Table K shows the totals by category for both 1988 and 1995. An increase of 36 percent in total trade and technical employment is expected. This represents a 4.5 percent per annum increase. These figures include system employment totals.

Table K
Total Employees by Category

Number of Employees By Job Classification
1988 vs 1995

Classification	19 88		19 95	
	Perm.	P/T	Perm.	P/T
Aircraft Mechanic	2568	48	3472	40
Engine & Acc. Mechanic	498	3	690	7
Prop/Rotor Blade Mechanic	19	20	30	7
Fuel Control & Acc. Mechanic	22	1	35	1
Rotary Wing Mechanic	18	8	20	11
Avionics/Instrument Technician	1129	6	1512	3
Sheet Metal/Structures Technician	962	17	1219	4
Welder/Plater/Metal Finisher	88	2	120	4
Composites/Plastics Technician	113	4	246	1
Tool & Die Maker	12		20	
Machinist	267	1	427	6
NDT Technician	57		94	4
Upholsterer/Refurbisher	464	3	672	3
Painter/Stripper	130		174	2
Aerospace Engineer/Designer	53	5	58	6
Electrical/Electronics Technician/Engineer	53	1	67	1
Design Approved Representative		1		1
Draftsman	14			
Purchasing/Inventory	10			
Production Control	5			
Production Engineers	6			
Stores	20	1	4	2
Component Technician	16	1	32	
Cargo Gear	3	2	5	5
Manufacture			6	2
Quality Control	3		7	
Total	6530	124	8910	110

Note: System-wide employee figures for national carriers

The industry survey indicates that the largest increases in trade and technical employment is needed in the following categories:

Table L

SKILL SHORTAGE CATEGORIES
1988 - 1995

Aircraft Mechanic	909
Avionics/Instrument Technician	383
Sheet Metal/Structures Technician	257
Upholsterer/Refurbisher	200
Engine and Accessory Mechanic	192
Machinist	160
Composite/Plastics Technician	133

7) Peak Periods of Employment

The survey did not reveal pronounced peak periods of employment. The smaller air carriers do increase their employment in the Spring and Summer to meet increased travel demand.

8) Unionized Employees

There are some 2,300 trade and technical employees which are unionized in the British Columbia aerospace industry or 63.5 percent. The principle union is the International Association of Machinists and Aerospace Workers.

9) Trade and Technical Female Employees

The number of skilled females in the British Columbia aerospace industry is less than .05 percent. The industry expects that about one percent of the trade and technical employees will be female by 1995.

10) Employee Age

Large aerospace firms indicate that 31 percent of their employees are over 46 years of age. Additionally, 11 percent are now over 55 years of age. Many people in the over 46 year categories will be retiring over the next decade. Figure 13 shows the age of employees.

Average Age of Employees
Large Firms
(>100 Employees)

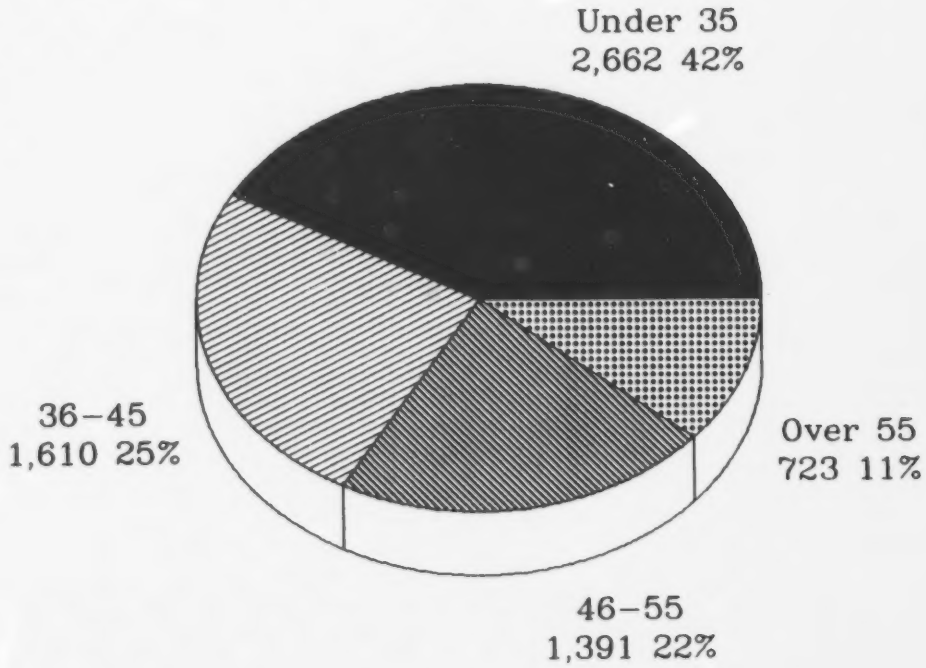

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Figure 13

Small firms have younger employees. Some 23 percent are over 46 years of age. Again, 11 percent are over 55 years of age. Figure 14 shows the age categories for the small firms.

11) Geographic Region of Hire

Figure 15 shows the geographic regions of hire over the past five years for trade and technical people employed by large firms. Most of the people hired are from British Columbia or Western Canada.

Figure 16, noting the geographic region of new hire for small firms, indicates that British Columbia is by far the largest source of new hires.

12) Origin of New Hires

The large firms report that most of their new hires come from vocational training institutes. The military and air carriers are also an important source of new hires. Figure 17 shows the results of the survey.

The small firms indicate a strong preference to obtaining their new hires from training institutes. Apprentice programmes, air carriers and other industry sectors are not as frequent sources of new hires. Figure 18 shows the origin of new hires for small firms.

13) Future Sources of New Hires

Most respondents indicated the same sources for new hires will be used in the future, indicating that training institutes are expected to be the principal origin of new hires in the future.

14) New Hires Out of British Columbia

Those that indicated they hired outside of British Columbia indicated the principal reason was the lack of qualified people in the province for the specific position.

Average Age of Employees
Small Firms

(<100 Employees)

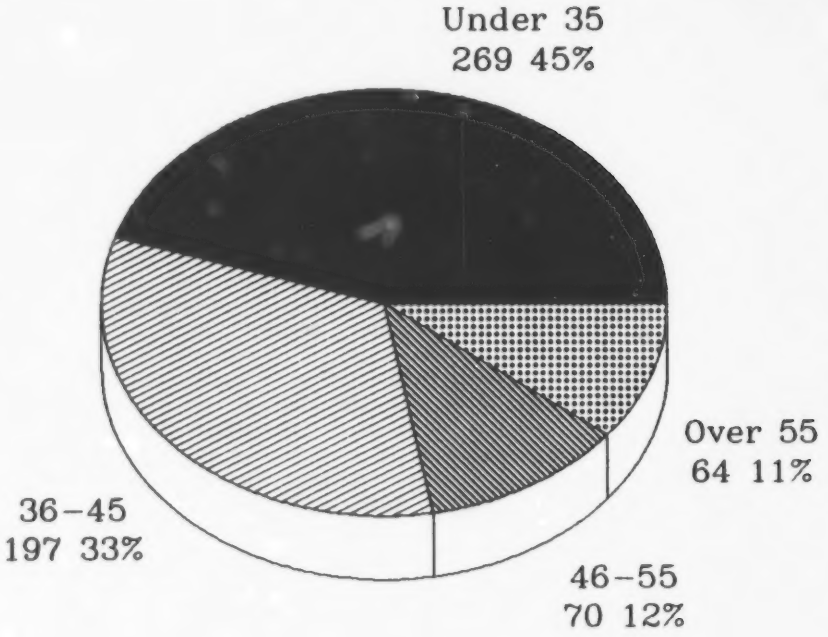

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Figure 14

Aerospace Personnel
Geographic Origins of New Hires
Large Firms

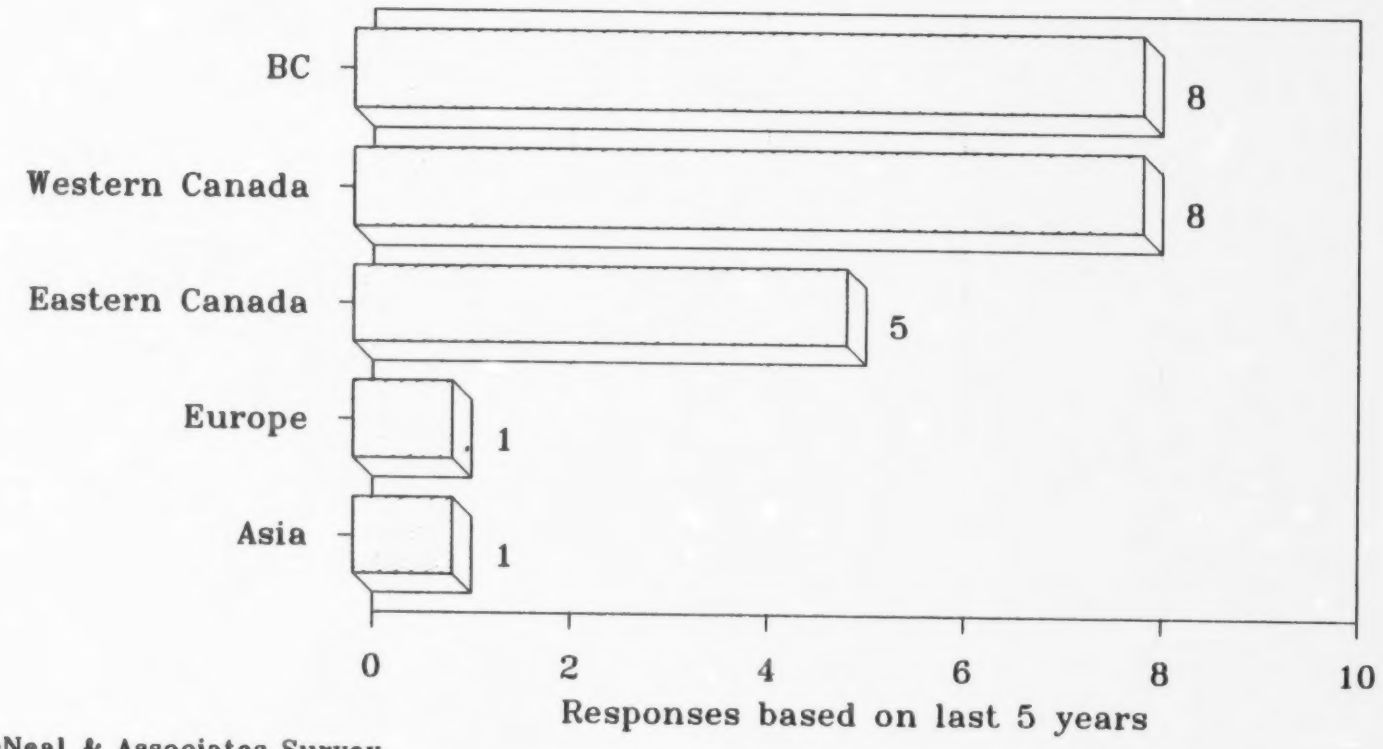

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Figure 15

Aerospace Personnel
Geographic Regions Hired From
Small Firms

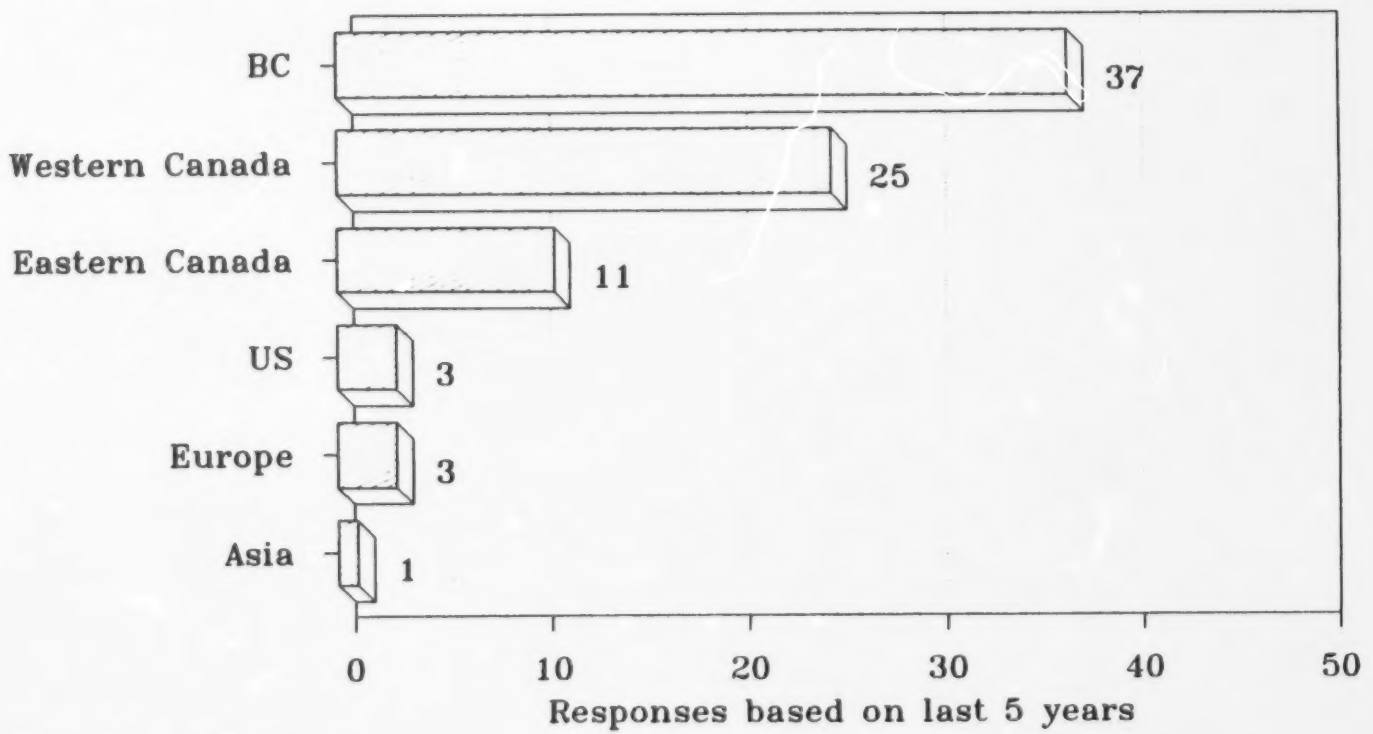

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Figure 16

Aerospace Personnel
Source of New Hires
Large Firms

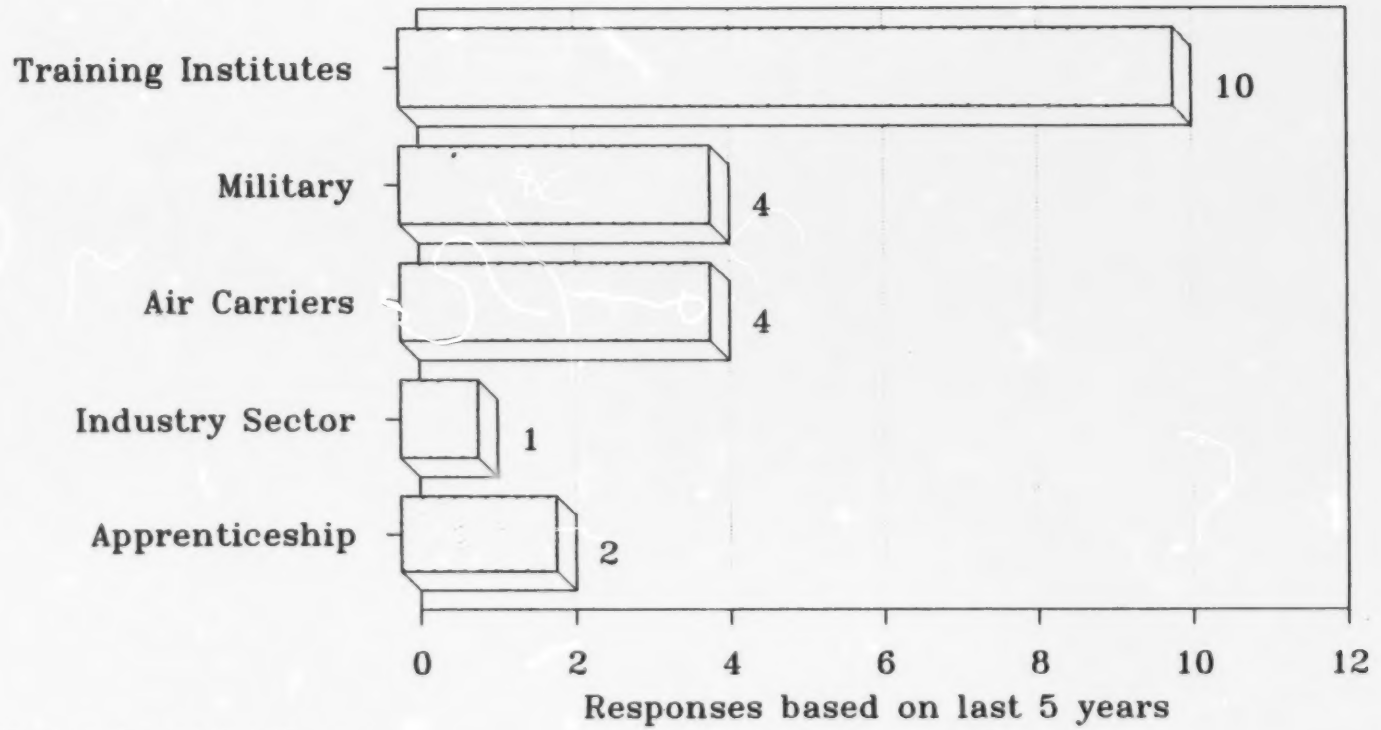

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Figure 17

Aerospace Personnel
Source of New Hires
Small Firms

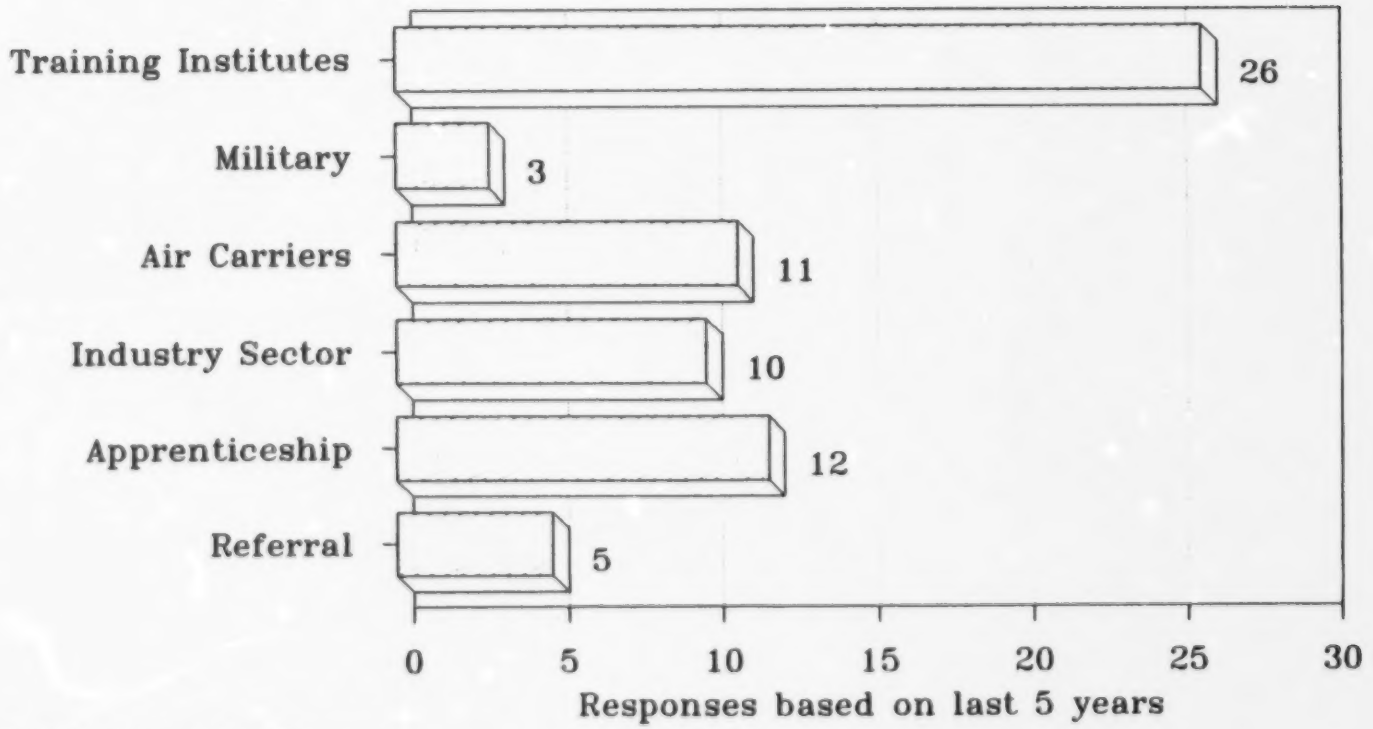

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Figure 18

15) Reasons for Employee Attrition

The large firms noted that layoffs and opportunities outside the aerospace industry were the principal reasons for employees leaving the firm. Shift work was also noted. Figure 19 shows the reasons for employee attrition for large firms.

Figure 20 shows the reasons for skilled employees leaving the smaller firms. Other employment within the industry (e.g. transferring to a larger air carrier) is the principal reason for leaving. Higher salary and benefits such as passes with the large airlines will also be noted as reasons for leaving.

16) Employee Motivation Programmes

Frequent salary reviews are the most frequent method of employee motivation. Bonuses and re-training are also mentioned as an inventive to motivate skilled employees. Apprenticing programmes were also noted. Figure 21 shows the various employee motivation programmes.

17) Multi-Skill Qualifications

Most aerospace companies expect their employees to be versatile and to be able to accomplish several tasks. The smaller companies, in particular, need people who can do several activities in the firm.

18) Use of Retired Workers

Aerospace employers are interested in using retired workers. They want recent retirees in the 50 to 65 year age bracket who have 20 to 30 years' experience. There seems to be little interest in those retired persons over 65 years of age or those not having recent experience.

Some companies now use retired people for special projects where their experience is desired. There is some interest from retired skilled workers to rejoin the work force, but likely only on a part-time basis.

19) Technology Changes

Those firms which responded that technological changes will affect the industry, indicated that the areas affected were in the use of composite materials, digital electronics, computer assisted production, and other computer-related technologies. A concern was expressed by some that people are not being trained in these new technologies.

Aerospace Personnel
Reasons for Leaving Firm
Large Firms

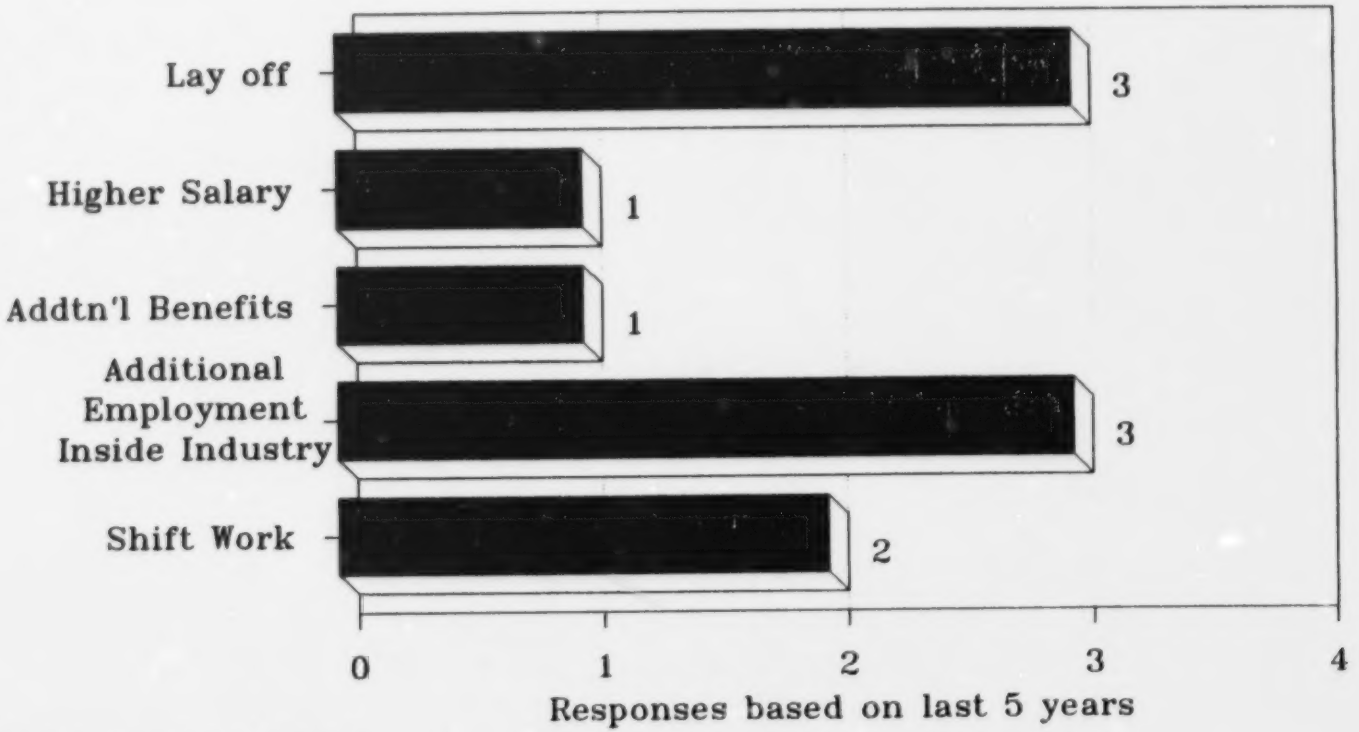

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Figure 19

Aersopace Personnel
Reasons for Leaving Firm
Small Firms

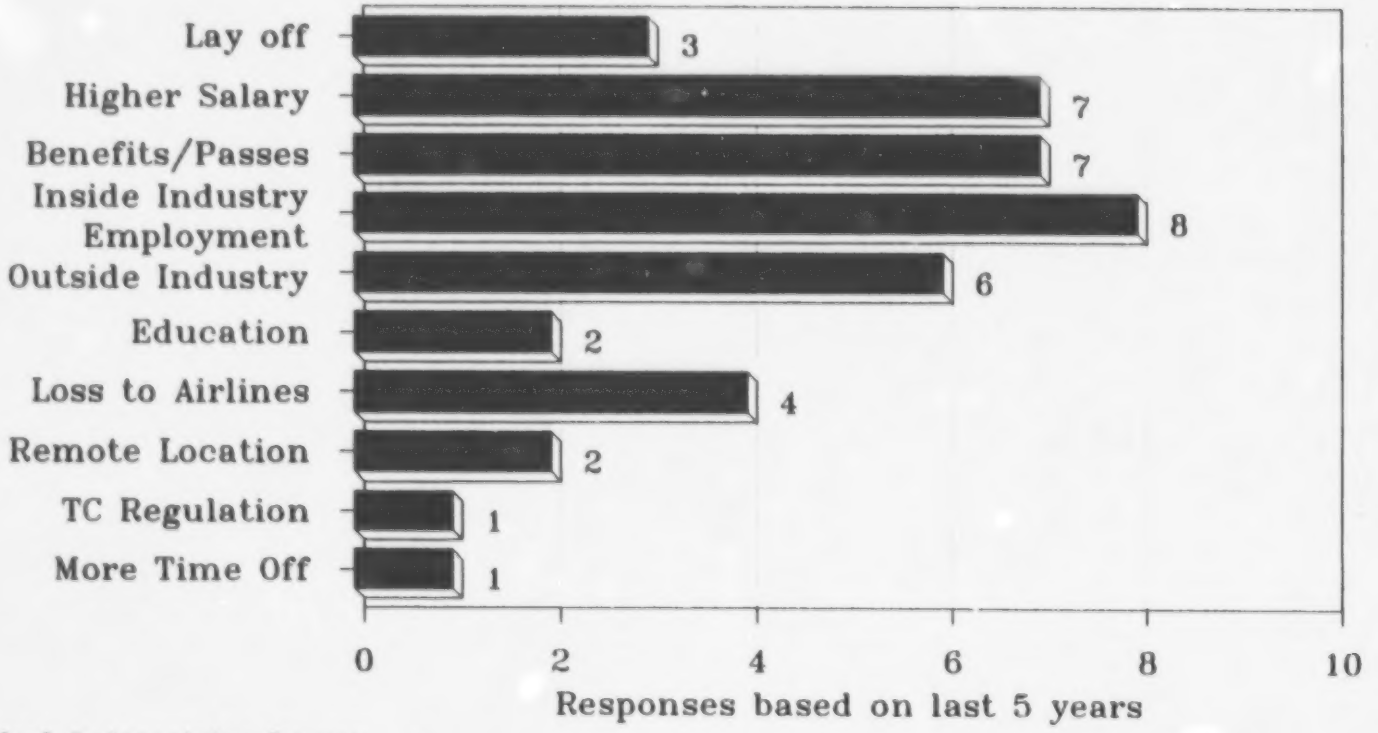

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Figure 20

Aerospace Personnel
Company Motivation Programmes

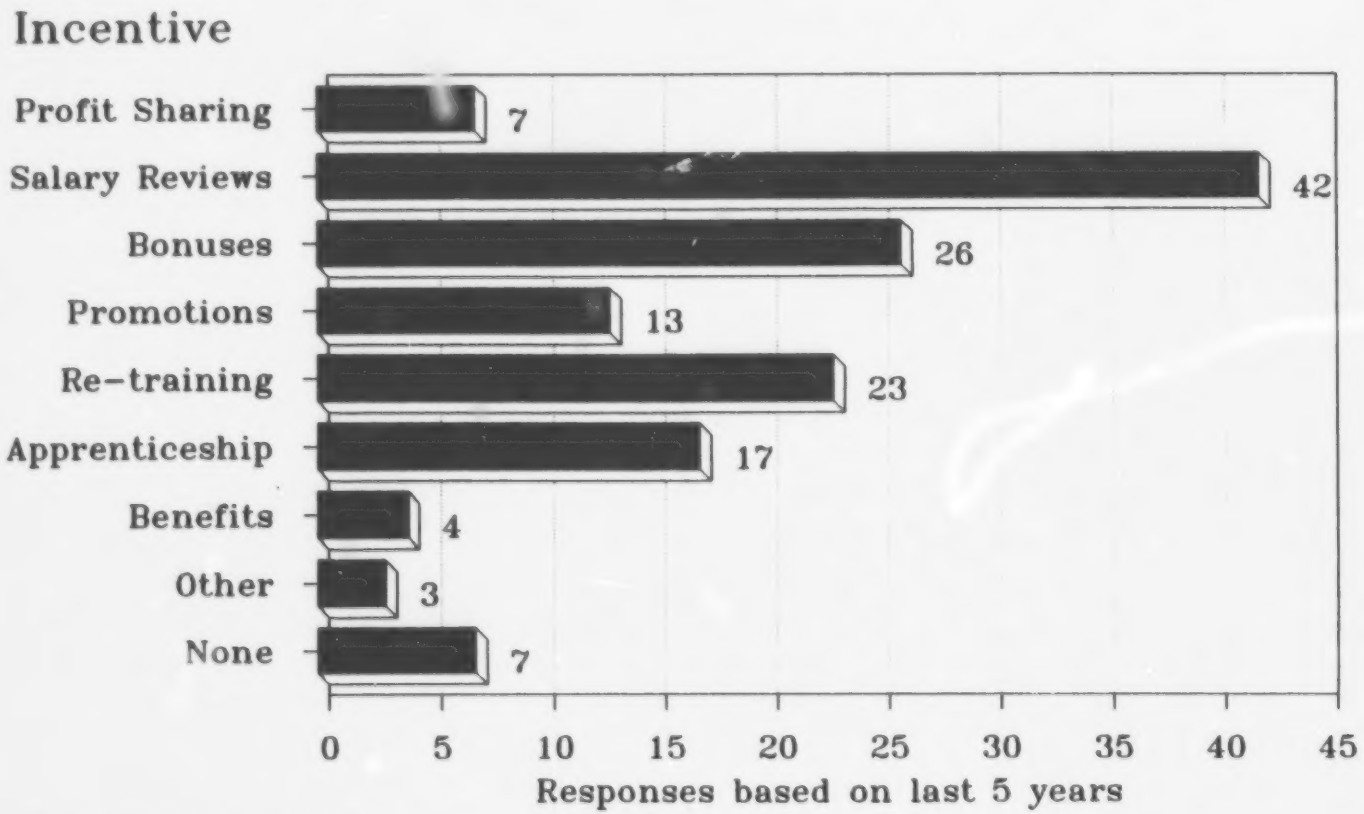

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Figure 21

20) Average Hourly Wages

Figure 22 shows the average hourly wages for skilled people working in large aerospace firms. The figures do not include shift differential or overtime pay. The majority of employees in entry level positions are in the $10-$15/hour range. Those employees with three years with the firm are mainly in the $10-$15/hour range as well. Most of the employees with five years with the firm are paid $15-$20/hour.

Figure 23 shows a similar pattern for the small firms. Those employees in entry level positions are paid less than $10/hour. Those with three years with the firm are mostly paid $10-$15/hour followed closely by $15-$20/hour category. Most of the employees with five years with the firm are paid $15-20/hour. Small firms tend to pay slightly higher than the larger firms. This may be a result of offering higher wages to experienced people to retain them in the company.

Wage levels have been cited as one of the reasons for skill shortage in the industry. A comparison was done of Canadian air carrier wages with the U.S. air carriers.

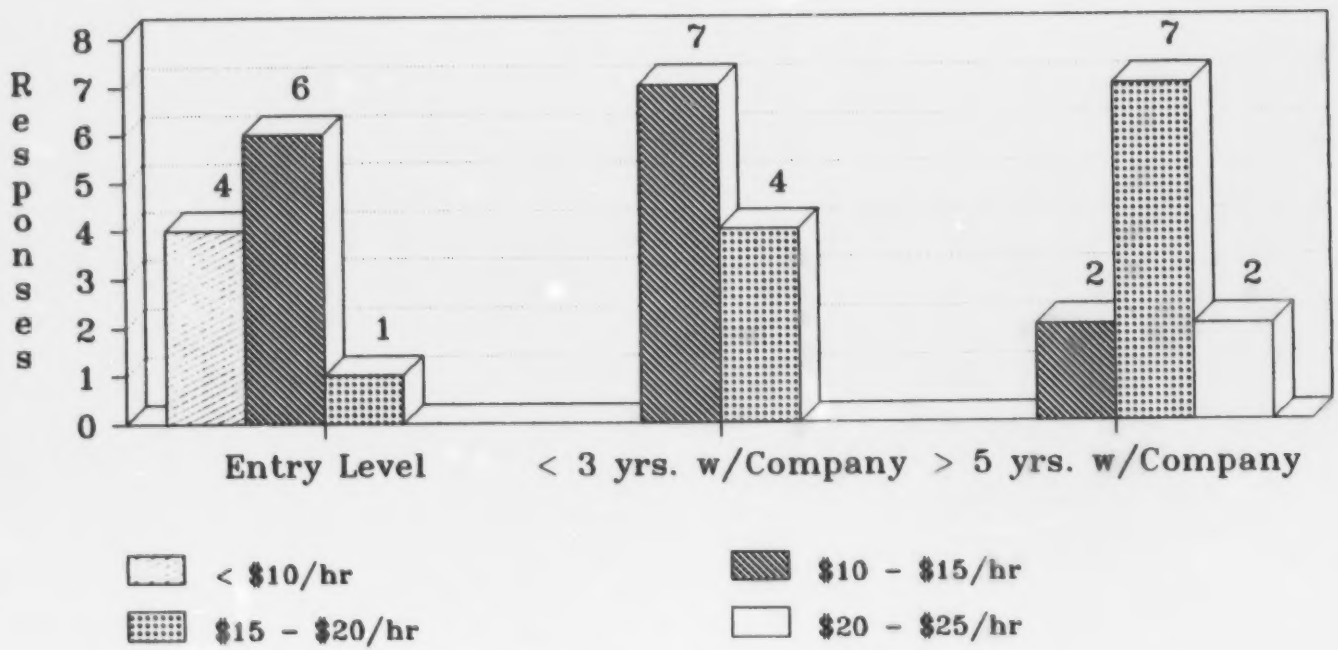
Table M shows the starting wage and wages for employees employed by Canadian air carriers. The average starting wage for the national airline is $12.00/hour and $15.13/hour for employees with three years' experience. Employees with the Canadian regional airlines and Canadian Helicopters can expect to start in the maintenance department at $11.67/hour and $14.04 with three years' experience.

Table N shows the starting wages for the U.S. air carriers. The table shows the wages in Canadian dollars. It also indicates the minimum qualifications. The major U.S. airlines have a starting wage of $13.83/hour. The U.S. national airlines have a starting wage of $13.33/hour. U.S. air carriers are abandoning the two tier pay system and the lower paying air carriers now pay a premium of up to $2 per hour to attract trained people. These are slightly higher than the Canadian equivalent wages but the U.S. employee will have an A&P license and general experience. An equivalent Canadian maintenance employee will have three years' experience.

Boeing wage rates vary from $8.88 U.S. an hour for new and unskilled workers to $18.42 U.S. for the most skilled. A year-end lump sum payment of 5 percent was paid in 1988.

A comparison was also made of other trade wages. Table O shows the occupational wages for union and non-union employees for construction occupations in the B.C./Yukon Region. The wages are shown for low and high rates, depending on experience. These wage ranges are similar to the AME wage range for union and non-union employees.

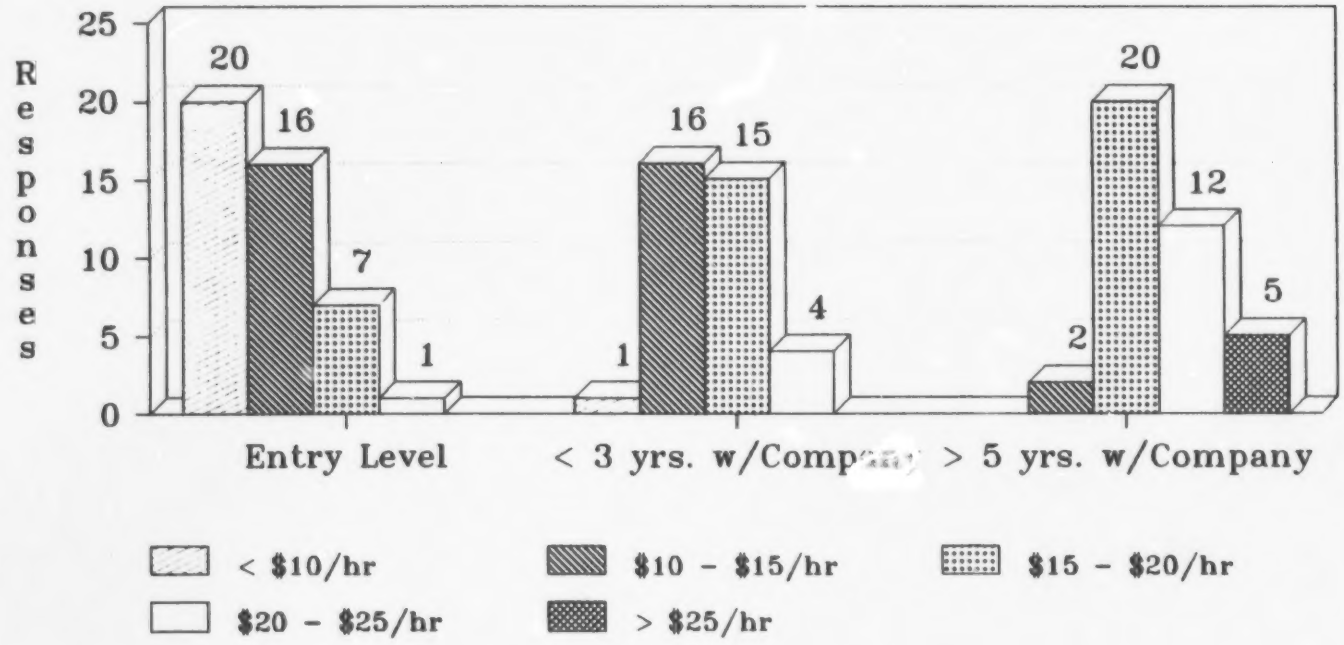
Average Hourly Wages
Trades/Technical Personnel
Large Firms



McNeal & Associates Survey
May 1989

Figure 22

Average Hourly Wages
Trades/Technical Personnel
Small Firms



McNeal & Associates Survey
May 1989

Figure 23

Table M
Wage Rates for Maintenance Personnel in the Canadian Airline Industry

Major Canadian Airline Maintenance Personnel Profile

Carrier	Total 1989	Starting Wage (Cdn $)	3 Years Experience Wage
Air Canada	2833	$13.00	$15.39
Canadian Airlines	1949	$13.00	$17.50
Wardair	296	$10.00	$12.50
Totals/Averages	5,078	$12.00	$15.13

Regional Canadian Airlines Maintenance Personnel Profile

Carrier	Total 1989	Starting Wage (Cdn $)	3 Years Experience Wage
AirBC	127	$15.00	$17.50
Canadian Helicopters	421	$10.00	$12.50
Time Air	80	$10.01	$12.11
Totals/Averages	628	$11.67	$14.04

Source: McNeal & Associates Survey, May, 1989

Table N
Wage Rates for Maintenance Personnel in the US Airline Industry

Major US Airline Maintenance Personnel Profile

Carrier	Total 1989	Hired 1988	Starting Wage (US$)	Starting Wage (Cdn $)	Minimum Qualifications
American Airlines	5100	566	$10.50	$12.08	A+P + 36 months
Continental Airlines	5000	n/a	$10.00	$11.50	A+P
Delta Airlines	4800	350	$11.00	$12.65	A+P
Eastern Airlines	4000	111	$11.46	$13.18	A+P + Sheetmetal
Federal Express	565	41	$12.28	$14.12	A+P
Flying Tiger	1200	102	$13.85	$15.93	A+P + Aptitude Test
Northwest Airlines	4000	485	$13.25	$15.24	A+P + Experience + Tech School
Pan American	3378	882	$9.65	$11.10	A+P + 12 months
Piedmont Airlines	1900	139	$12.16	$13.98	A+P + 20 months
Trans World Airlines	6500	177	n/a	n/a	A+P
United Airlines	9200	1644	$13.76	$15.82	A+P
USAir	3020	546	$14.38	$16.54	A+P + 36 months
Totals/Averages	48,663	5043	$12.03	$13.83	

National US Airlines Maintenance Personnel Profile

Carrier	Total 1989	Hired 1988	Starting Wage (US$)	Starting Wage (Cdn $)	Minimum Qualifications
Airline Express	526	65	$13.00	$14.95	A+P + 24 months
Air Wisconsin	190	37	$8.90	$10.24	A+P + 24 months
Alaska Airlines	200	46	$10.81	$12.43	A+P + 36 months
Aloha Airlines	160	78	$10.60	$12.19	A+P + Endorsement
American Trans Air	222	205	$9.25	$10.64	A+P + 24 months
America West	300	138	$13.89	$15.97	A+P + 24 months
Braniff	800	96	$12.00	$13.80	A+P + Endorsement
DHL Airways	80	55	$11.16	$12.83	A+P + 6 months
Evergreen International	149	54	$12.00	$13.80	A+P + 24 months + Endorsement
Hawaiian Airlines	400	66	$10.98	$12.63	A+P + Endorsement
MGM Grand Air	20	n/a	$13.46	$15.48	A+P + 36 months
Midway Airlines	200	21	$13.00	$14.95	A+P + 24 months + Endorsement
Southwest Airlines	252	158	$13.61	$15.65	A+P + 24 months + Endorsement
United Parcel Service	120	306	n/a	n/a	A+P + 72 months
Zantop International	325	75	$9.65	$11.10	A+P + 36 months
Totals/Averages	3944	1400	$11.59	$13.33	

Note: Conversion of US$ to Cdn$ at 15%

Source: FAPA

Table O
Occupational Wages in the Construction Industry

Occupational Wages

Trade	Union	Non-Union
Electrician	$15.00-21.00	$14.00-19.00
Carpenter	$14.49-20.30	$10.00-19.00
Interior Trimmer	$14.49-20.30	$10.00-19.00
Painters/Decorators Helper	$9.78-19.77	$7.50-18.00
Plumbers/Plumbers Apprentice	$17.00-19.00	$9.00-16.00

Metro District BC/YT Region for Construction Trades

The wages are stated in hourly wage rates as indicated from the survey and other information sources. These figures do not consider the number of hours worked during a year or overtime rates. These factors influence the total wage rates paid to aerospace workers or other trade groups noted in the wage comparisons.

21) Skill Shortages

Table P, overleaf, shows where skill shortages are now being experienced or expect to be experienced by 1995. The larger firms responding to the industry survey indicate skill shortages in the sheet metal/structures technician and aircraft mechanics categories. The small firms report skill shortages in aircraft mechanics, engine and accessories mechanics, avionics/instrument technician, and machinist categories. Two of the large firms indicated no anticipated skill shortages and 18 of the small firms noted that they expect no skill shortages.

22) Education Requirements

Large firms require high school or technical school for their minimum education requirements. Figure 24 shows the response by large firms.

Figure 25 shows the responses from small firms. Technical School is the desired education level for the small firms.

Table P
Skills Shortages Expected by Questionnaire Respondents

Skills Shortages By Job Classification

Classification	Large Firms Responding	Small Firms Responding
Aircraft Mechanic	5	7
Engine & Acc. Mechanic	2	6
Prop/Rotor Blade Mechanic		1
Fuel Control & Acc. Mechanic	1	1
Rotary Wing Mechanic	1	3
Avionics/Instrument Technician	4	6
Sheet Metal/Structures Technician	6	3
Welder/Plater/Metal Finisher	2	1
Composites/Plastics Technician	5	2
Tool & Die Maker		2
Machinist	2	5
NDT Technician	3	1
Upholsterer/Refurbisher		1
Painter/Stripper	2	
Aerospace Engineer/Designer	3	1
Electrical/Electronics Technician/Engineer	2	3
Industrial Engineering & Estimating	1	
No Anticipated Skills Shortages	2	18

Aerospace Personnel
Company Education Requirements
Large Firms

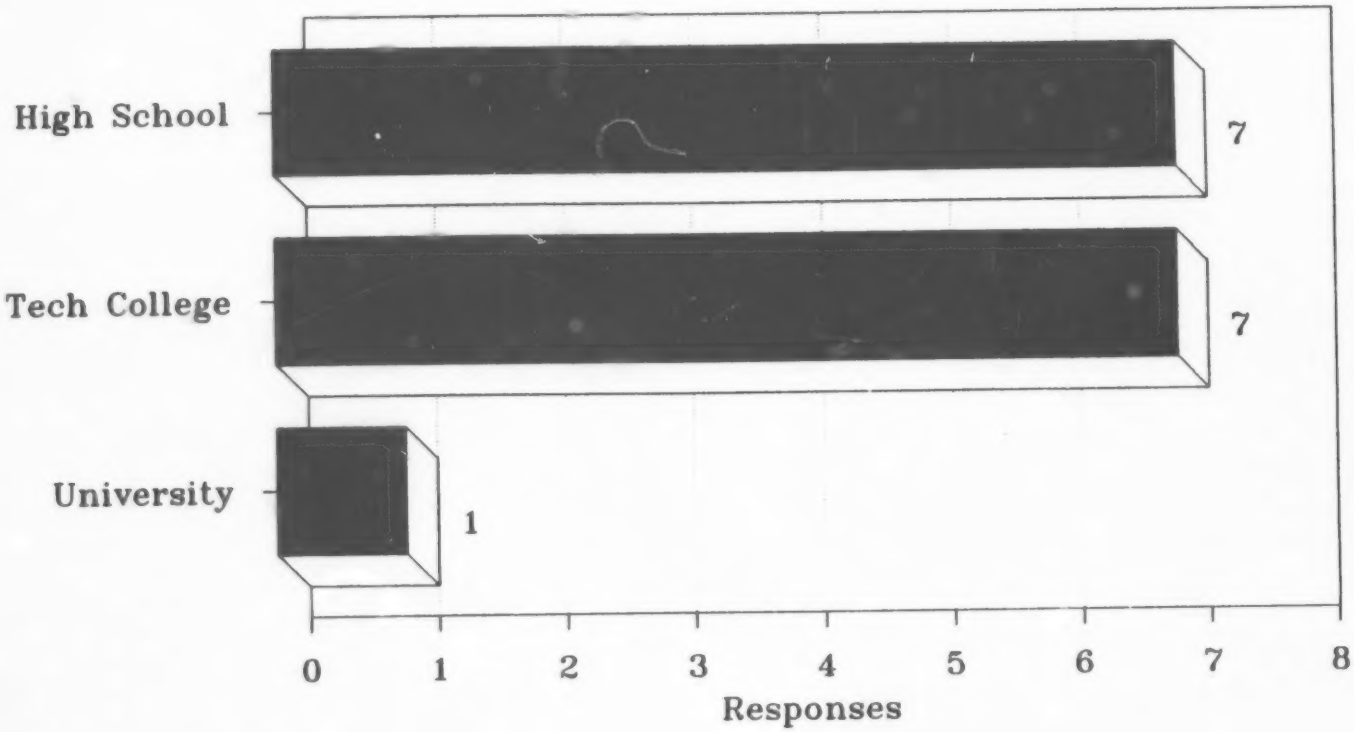


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Figure 24

Aerospace Personnel
Company Education Requirements
Small Firms

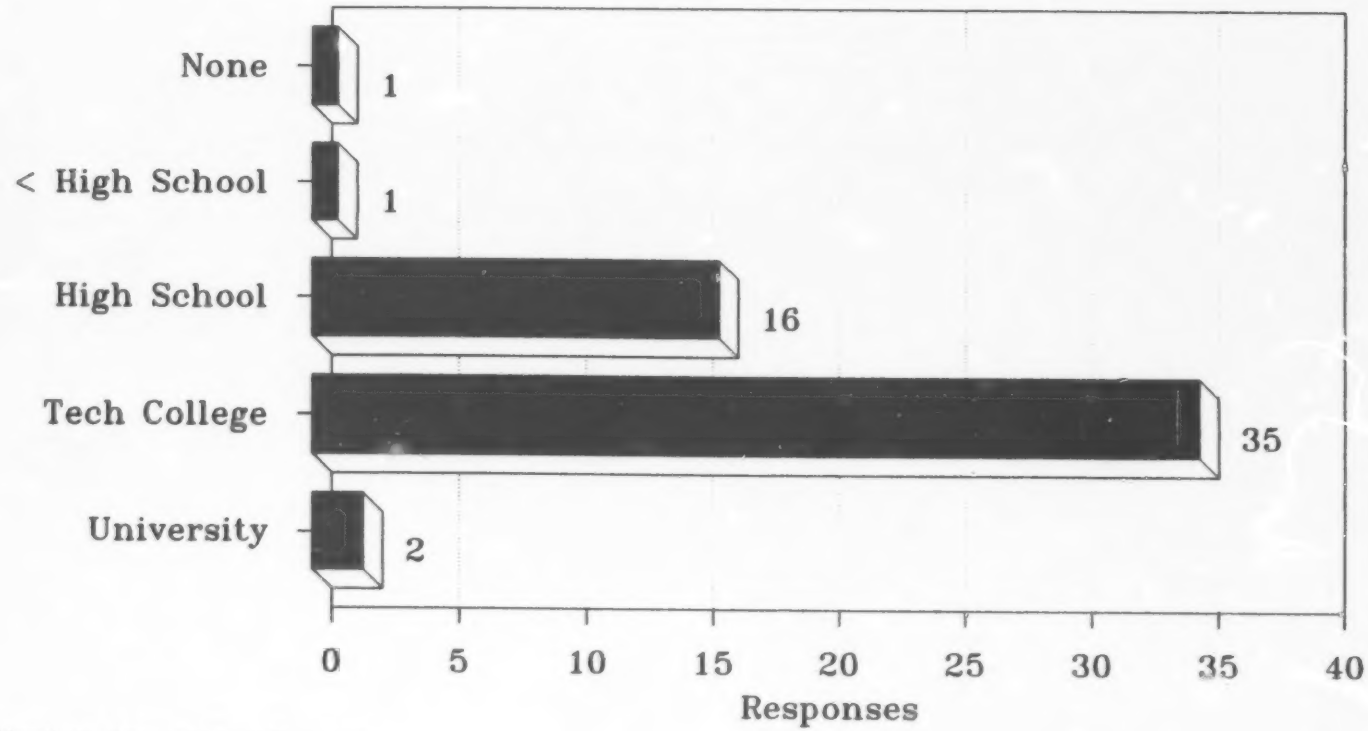

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Figure 25

23) Experience Requirements

Figure 26, overleaf, shows that large firms are looking for 1-2 years' experience with new hires.

Figure 27 also shows that small firms are looking for 1-2 years' experience in general. A number, however, require over 5 years of experience.

24) Licences/Certification

Large firms desire an AME licence with emphasis on "A" aircraft mechanic and "E" avionics. Figure 28 shows the results from the large firms.

Figure 29 shows that small firms also desire an AME licence.

25) Training Programmes

Companies which have training programmes tend to be larger firms. Those firms with over 20 people in the maintenance department usually have some type of training programme. The training format was in a classroom but home study was also noted. Several firms sent their employees to manufacture training. Few reported employees taking further educational training. No trade or union sponsored training was noted by the respondents.

26) Employees in Training

The industry survey revealed that some 45 percent of their employees had taken an internal training programme in 1988. Only 3 percent of the employees, however, were trained by external training organizations.

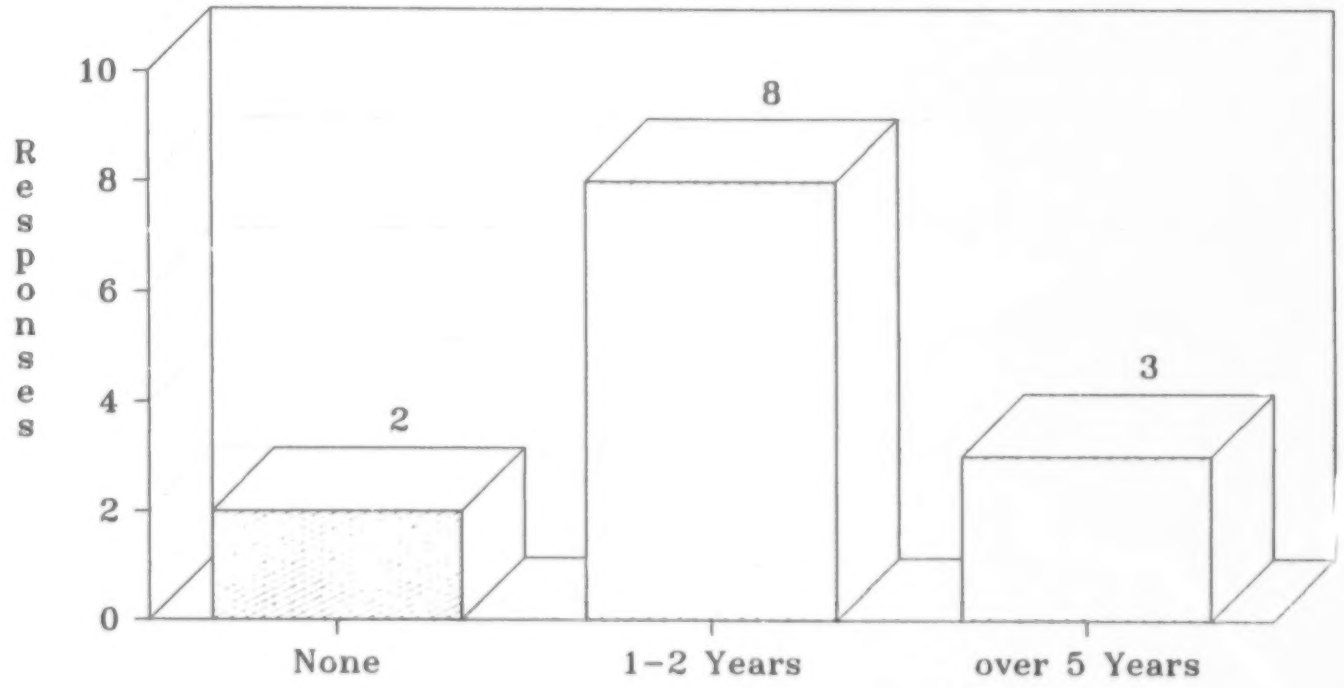
27) Training Assistance

Some 13 firms reported that they had received government financial assistance for employee training. Of the firms which had not received financial assistance, 27 indicated interest in receiving training assistance in the future.

28) Aerospace Issues

The industry was requested to provide their opinion on some of the key aerospace issues which affect skill requirements in the British Columbia aerospace industry. The results of the "Aerospace Issues" are shown in Figure 30.

Aerospace Personnel
Company Experience Requirements
Large Firms



McNeal & Associates Survey
May 1989

Note: The 3 over 5 Year Experience Requirements stated that this was desired, not required

Figure 26

Aerospace Personnel
Company Experience Requirements
Small Firms

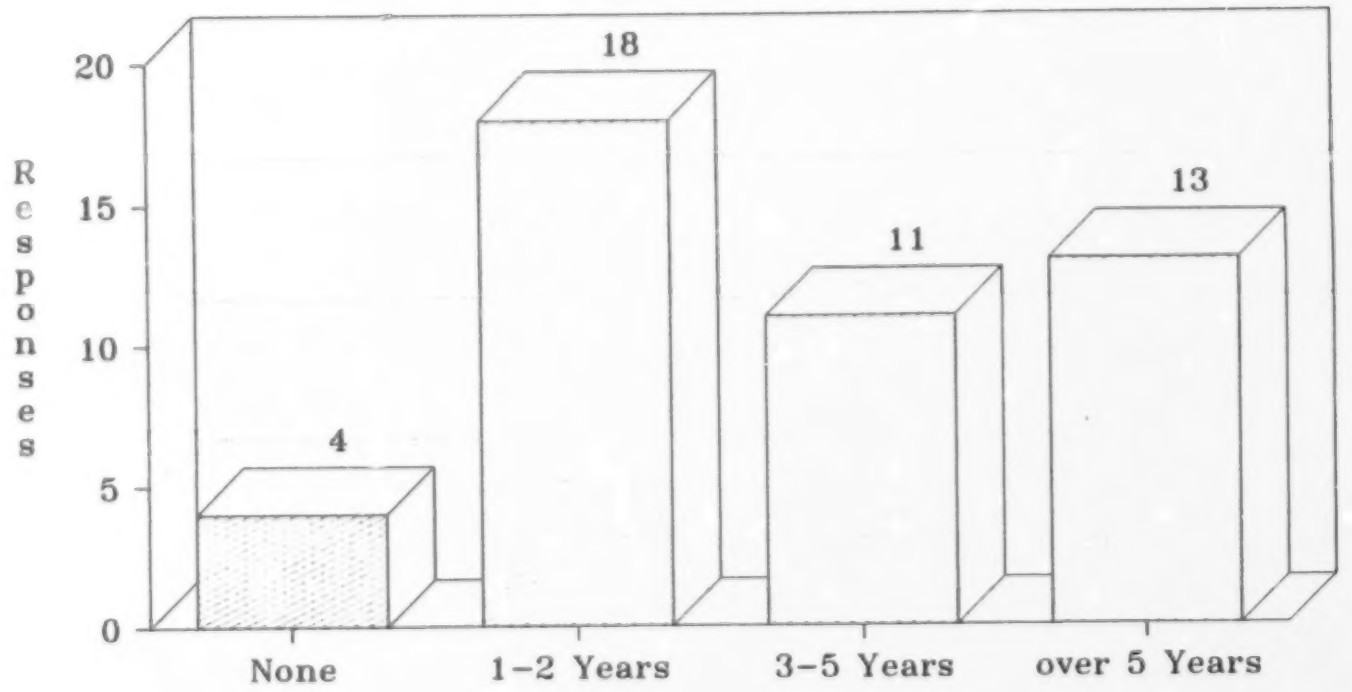


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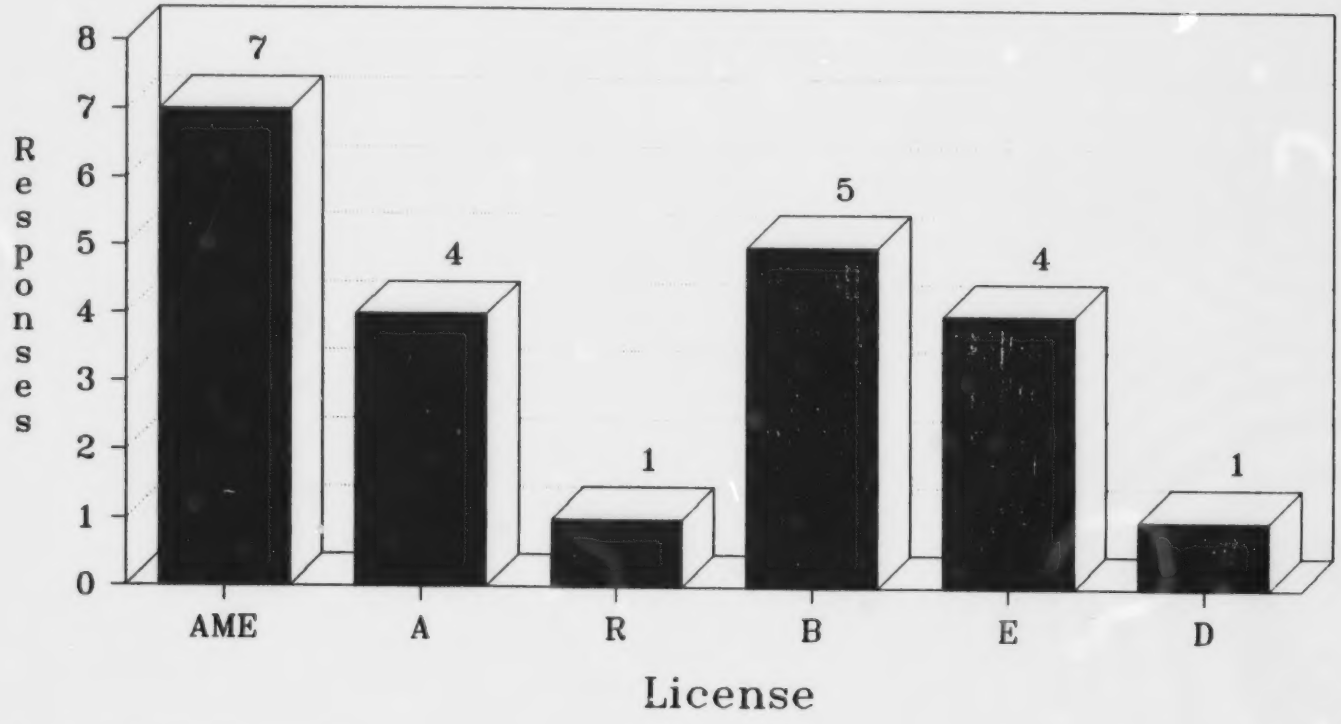
Figure 27

Aerospace Personnel
Company License/Certificate Requirements
Large Firms



McNeal & Associates Survey
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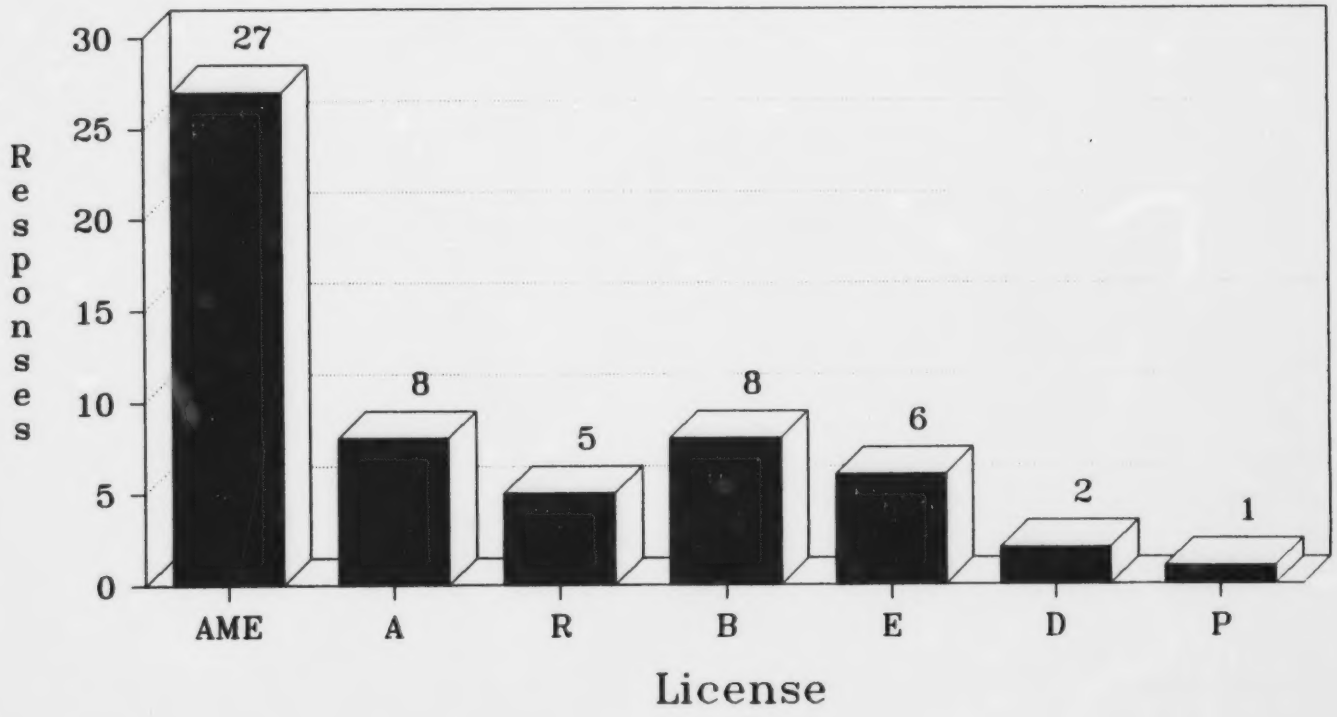
Figure 28

Aerospace Personnel
Company License/Certificate Requirements
Small Firms



McNeal & Associates Survey
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Figure 29

Figure 30

BRITISH COLUMBIA AEROSPACE LABOUR STUDY

AEROSPACE ISSUES

Aerospace Issues	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. There should be tougher regulations regarding aircraft age, corrosion inspection, and other airworthiness factors to ensure safer aircraft.	5	9	19	19	10
2. All employees who work on aircraft should have the appropriate certification and/or license.	1	11	8	24	18
3. Transport Canada should be the only agency to issue aircraft/system endorsements, not the air carrier or manufacturer.	12	21	8	18	1
4. The proposed changes in AME endorsements will provide the required responsiblity of appropriate work tasks and inspections.	3	8	23	19	3
5. The lack of qualified replacements for skilled employees makes the BC aerospace industry vulnerable to competition from other technology industries.	2	8	11	34	6
6. There should be more consultation and cooperation between technical training institutes and members of the aerospace community.		4	7	40	10
7. There should be greater emphasis on upgrading and retraining current employees.		1	11	44	6

Aerospace Issues	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
8. There is a need for government to provide more training programs that support the B.C. aerospace industry's efforts.	2	4	9	32	14
9. There is a need for technical training institutes to adopt a curriculum which reflects changing industry requirements.	1		4	36	17
10. Additional skilled people can be attracted to the aerospace industry by increasing wage rates.	3	15	18	20	5
11. There is a need for additional inspection and recording procedures in aircraft manufacturing/ maintenance.	7	17	19	13	4
12. Skills from other industry areas can be readily transferred to the aerospace industry.	3	32	9	13	4
13. The B.C. aerospace industry has the economy-of-scale size to be effective in its future development.	2	17	18	21	
14. New employees have the necessary dedication and pride in the aerospace industry.	3	8	27	21	1

Aerospace Issues	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
15. Deregulation of air transport has created opportunities in the aerospace industry.	3	4	15	30	8
16. Aerospace apprenticeship programmes should be recognized by the government.			7	37	16
17. Aerospace unions have a large role in shaping the future of the aerospace industry.	11	22	16	11	1
18. Current procedures for obtaining an AME license are adequate to meet both industry and safety needs.	1	10	16	29	3
19. Transport Canada should have practical tests as well as exams for obtaining a license.		9	16	27	8
20. Current experience requirements for an AME license are not adequate for the needs of the industry.	3	17	23	15	
21. The aerospace industry should provide a commitment to technical training schools for a minimum number of graduates each year.	1	6	26	24	2
22. The aerospace industry is responsible for providing both formal and on-the-job training for its employees towards credit for an AME license.	1	6	13	37	3

7.0 FORECAST OF THE AEROSPACE MARKET

7.1 Development of Forecast Scenarios

Development of a forecast for the demand for skilled technicians and maintenance engineers is difficult due to the uncertainty several of the key forecast variables. The British Columbia aerospace industry has been subject to cycles of high and low activity periods in the past. These cycles will likely continue in the future. It is anticipated, however, as the industry grows and matures, that the variations between peak and low periods of activity will be reduced. The unpredictable variables include the world and regional economies as they affect the demand for air travel and the need for aircraft. They also include external forces such as government regulations, corporate decisions by major aerospace companies, capital requirements for aircraft, plant and equipment costs and the availability skilled labour. Table Q, overleaf, lists some of the supply and demand factors to be considered.

To develop projections because of the uncertainly of the future, scenarios were developed to provide a range of forecast demands for skilled aerospace labour. Each scenario has its own set of assumptions about the future growth of the British Columbia aerospace industry.

Table Q

SUPPLY AND DEMAND FACTORS WHICH
AFFECT SKILLED AEROSPACE LABOUR AVAILABILITY

SUPPLY FACTORS:

- Wages and salaries
- Job satisfaction (greater job satisfaction reduced turnover)
- Transferability of skills (skills which can be used in various industries and job categories)
- Attrition (retiring workers create new jobs for younger personnel)
- Career advancement opportunities
- Assistance (company or government) for job training
- Demographics/labour pool availability
- Liveability (climate and amenities of employment area)

DEMAND FACTORS:

- Increased market opportunities for products and services
- Technological changes requiring different skills
- Changes in level of production
- Increase in market scope (e.g. export markets)
- Investment in research and development
- Quality assurance standards (e.g. Transport Canada's increased airworthiness standards)
- Increased competition (e.g. customer service levels increased)
- Government assistance for capital or operating expansion
- New types of activities or sub-contracts
- Economy

The following scenarios illustrate the possible range of alternatives:

SCENARIO #1: NEGATIVE GROWTH

The aerospace industry experiences negative growth. Current major air carrier maintenance employment levels are assumed to be reduced as maintenance activity is transferred out of British Columbia for corporate or economic reasons. Existing sub-contracts with major aerospace firms are terminated or transferred to other sub-contractors outside of British Columbia who offer a lower cost and/or better delivery capability of aerospace component products. Existing aerospace firms change corporate policy and close down their aerospace activities. All these actions could have a negative effect on aerospace growth in the province.

SCENARIO #2: STATUS QUO

The status quo scenario assumes that the British Columbia aerospace industry remains similar to the present industry in its size and range of activities. Any growth in employment is tied to the Canadian economy. The OECD expects Canada will experience a 3.5 percent growth rate per year in the early 1990's and decreasing to 2.75 percent by the middle of the 1990's. The scenario will reflect these OECD conservative growth rates.

SCENARIO #3: MODEST GROWTH

The assumptions used in the modest growth scenario assumes that the British Columbia aerospace grows as a result of taking advantage of some of the available market opportunities. It also assumes that the aerospace industry is strongly influenced by international factors and that British Columbia is included in the globalization trend taking place in both the airline and aerospace manufacturing industries. ICAO and Boeing forecasts assume that traffic and the number of jet aircraft will double before the year 2000. The British Columbia aerospace industry is assumed to expand at about 4.5 percent per year, somewhat lower than the ICAO and Boeing forecasts. Based on the industry survey, this is the same growth rate which the British Columbia aerospace industry itself expects to grow between 1988 and 1995. After 1995, the growth rate assumed is 3.5 percent per annum.

SCENARIO #4: HIGH GROWTH

The assumptions built into this scenario indicate that the British Columbia aerospace industry will experience significant growth over the next decade. The growth will be as a result of aggressive marketing on an international scale of its products and services. It further assumes that British Columbia takes advantage of its Pacific Rim gateway location for becoming a strong international airline and aerospace manufacturing centre. Growth rates of over 6 percent per annum are seen under the high growth scenario for the period 1988 to 2000. This scenario incorporates several "special initiatives" which will ensure high rates of growth are achieved in the forecast period. These "special initiatives" are based on the aerospace opportunities identified in an earlier section and detailed below:

SPECIAL INITIATIVES

"Special initiatives" which would see the realization of British Columbia becoming a major aerospace centre include the following aerospace opportunities:

INITIATIVE I

British Columbia develops a major aircraft overhaul and repair facility similar to the Hong Kong Aircraft Engineering Co. (HAECO) operation at Kai Tak Airport or Bedek Aviation in Israel. The facility could be developed on its own or with a consortium of international airlines plus overhaul and repair firms with the appropriate qualifications and experience. A major aircraft overhaul and repair centre would require about 650 trades people. Of the 650, 250 would need to be qualified skilled aircraft maintenance engineers (AME's). It is expected that about 25 engineering planners and aeronautical engineers would also be required.

INITIATIVE II

Development of a jet engine repair and test centre for the new generation of aircraft. An engine overhaul and repair facility which specializes in General Electric CF6 and CFM56 engines could become a North American centre for these engines. This facility would not only be for the Canadian airlines, but also for airlines in the United States and Asia that operate aircraft with the same engine type. An engine centre capable of handling 100 jet engines a year would likely require a work force of 250 trades people. Of these, 150 would have the necessary certification standards (AME's).

INITIATIVE III

Development of a major aerospace structures facility for aerospace components such as aircraft wing or fuselage components. The facility would require the participation of large, experienced aerospace contractor to establish a branch plant on its own or in co-operation with existing British Columbia aerospace manufacturers. The large aerospace partner would provide the market, production expertise and reputation. Capital for assistance in the development of the facility would likely be required to attract a major aerospace structures firm to the province. It is estimated that a large aerospace structures facility would require about 400 skilled trades people, of which about 50 would require to be AME qualified.

INITIATIVE IV

Development of an aerospace complex within an international duty exempt zone is a possible special initiative. The Canada-US Free Trade Agreement provides Canadian companies with an opportunity to conduct value-added assembly on foreign produced components and to market the final product in the United States as a Canadian made product. This allows foreign products indirect access to the large US market which currently may be restricted by duties and tariffs. This initiative would assist the movement of trade goods through British Columbia and would encourage foreign manufacturers to use the facility to produce final assembly items for export.

Canada and the US also have an airworthiness bilateral agreement which eases regulatory hurdles about accepting aircraft overhaul and repairs of aerospace products. Goods or services which meet Canadian content regulations have ready access to the U.S. aerospace market.[14] An aerospace centre located in a duty exempt zone could attract several large and small foreign firms interested in accessing the US market via British Columbia. The zone can be incorporated within an existing manufacturing facility. Pacific Rim firms, in particular, could be interested in British Columbia's strategic position in relation to the major US aerospace markets. Such a zone could employ 150 trade people with perhaps 100 being skilled AME people.

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[14] see Blaser, Fred, "Origin rules complicate US pact", Financial Post, August 4, 1989

INITIATIVE V

Expansion of existing aerospace contracts into new products manufactured by deHavilland and Canadair such as the proposed DHC-8-400 series commuter or the new Canadair Regional Jet program. Expansion of existing contracts would provide employment for an additional of 175 skilled people of which 25 would be skilled AME's.

INITIATIVE VI

The development of an aircraft modification centre(s) is another initiative. The modification centre would modify existing aircraft to meet changing market conditions. Such modifications could include re-engining, fuselage extensions, hush-kitting of jet engines, interior refurbishment, cargo interiors and doors, and other engineering changes and structural design modifications. The modification centre (s) could be an extension of existing repair and overhaul operations or a new establishment. The principal market areas would be regional air carriers, air cargo operators, specialty air carriers, business aircraft and military transport aircraft. The modification centre(s) could employ up to 200 trade and technical people, of which 125 would be aircraft engineering maintenance and structure staff (AME). The centre(s) would also need about 20 aeronautical engineers and production/planning engineers, in addition to the trade employees.

INITIATIVE VII

Divestiture of military aircraft maintenance at CFB Comox is another potential special initiative. The Department of National Defense is currently investigating the use of private sector firms for certain operations. One of the possible areas for consideration is aircraft maintenance. Civilian contracts are now used to conduct some of the major aircraft overhaul and repair needs as well as aircraft modifications. The concept could be expanded in British Columbia to produce new aerospace opportunities.

Line maintenance and inspections currently taking place at CFB Comox could be assigned to a civilian operation. There are four operational units at CFB Comox. VU 33 Squadron operates Grumman Trackers (CP-121) and T-33's (CT-133) and has 50 maintenance people on staff. The CP-140 Aurora patrols are operated by VP 407 Squadron and have 240 maintenance staff including avionic technicians in the squadron. The search and rescue squadron 442 T and R operate the deHavilland Buffalo DHC-5 (CC-115), Boeing Vertol Labrador CC-113 and Voyageur CC-113A. They have approximately 150 maintenance personnel in the squadron. Two CF-18 Hornets are rotated to CFB Comox from Cold Lake, Alberta and are part of 441 Tactical Fighter Squadron. About 35 maintenance technicians are rotated along with the CF-18 aircraft. In total there are about 475 maintenance personnel at CFB Comox.

A private initiative to undertake the non-fighter jet maintenance at the base would require about 400 trained trade and technician staff. There would be a need for about 125 of these skilled people to have AME certification or equivalent military TQ-5 standards. Military maintenance personnel would be re-assigned either to other military bases which are short of personnel or to assignments where military security is required.

Table R, overleaf, summarizes the number of skilled trade and technical personnel needed for each of the seven broad initiatives identified. The table also shows the projected number of AME's also required for each of the initiatives. The skilled labour needs are shown by year for the period 1990 to 2000.

7.2 Forecast

The skilled aerospace labour forecasts were calculated for each of the scenarios developed. The following summarizes the forecast results for the period 1988 to 2000. The forecasts do not include replacement employees for attrition, such as retirement, over the next decade.

7.2.1 Scenario #1: Negative Growth

The forecast development under this scenario assumes that several existing aerospace activities are transferred out of the province and/or current programs curtailed. Approximately 1,410 skilled jobs could be lost to the province. It assumes that the remaining aerospace industry will continue to grow, but at only 3.3 percent per annum.

Figure 31, overleaf, presents the Scenario #1 forecast.

In 1995, there are 1,535 fewer skilled people than expected. This shortage results from the comparison between the number of employees needed to meet the industry expected growth as indicated by the industry survey, . There are 750 fewer AME's than expected, as well. By 2000 the gap widens. There are 2,250 fewer skilled people in 2000 than expected by the aerospace industry. The number of AME's is 1,100 fewer than expected by the year 2000.

7.2.2 Scenario #2: Status Quo

The status quo forecast under Scenario #2 assumes that the British Columbia aerospace industry grows about 3.5 percent between 1988 to 1995 and 2.75 percent between 1996 to 2000. These growth rates are below those expected by the British Columbia aerospace industry as noted from the industry survey results.

Table R
Special Initiatives Manpower Needs Summary

			1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
I	Airline Overhaul Base													
	Total Skilled	650				100	200	200	150					650
	AME	250				50	100	100						250
	Engineers	25					10	10	5					25
II	Engine Overhaul Base													
	Total Skilled	250					50	50	50	50	50			250
	AME	150					25	50	25	25	25			150
III	Major Aerospace Structures													
	Total Skilled	400			100	100	100	100						400
	AME	50				25	25							50
IV	Free Trade Zone													
	Total Skilled	150							50	50	50			150
	AME	100							25	50	25			100
V	Expansion of Existing Industry													
	Total Skilled	175	50	50	25	25	25							175
	AME	25		10	10	5								25
VI	Modification Centre													
	Total Skilled	200	50	50	50	50								200
	AME	125	25	50	50									125
	Engineers	20	5	10	5									20
VII	Military Privatization													
	Total Skilled	400							100	100	100	100		400
	AME or TQ-5	125							50	50	25			125
	TOTAL													
	Skilled	2225	100	100	175	275	375	350	350	200	200	100		2225
	AME	825	25	60	60	80	150	150	100	125	75			825
	Engineers	45	5	10	5		10	10	5					45

Maintenance Personnel Growth Forecasts
Negative Growth

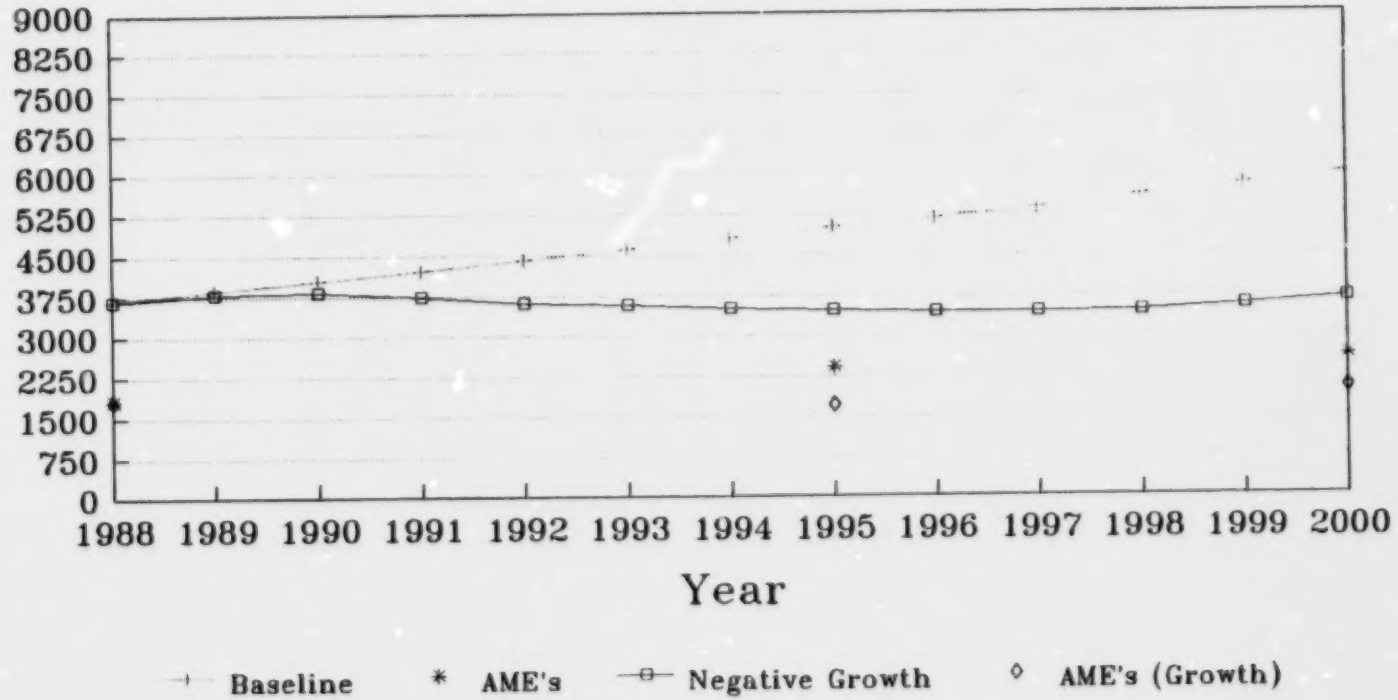

Figure 31

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July 1989

Figure 32 shows the results of the Scenario #2 forecast.

By 1995 there are some 325 fewer skilled people than industry expectations. There are 150 fewer AME's than expected. By 2000 there are 1,580 less skilled people than the aerospace industry anticipates. The number of AME's is projected to be 300 less than projected by industry.

7.2.3 Scenario #3: Modest Growth

The forecast of skilled aerospace workers in the modest growth scenario parallels the growth expectation of the British Columbia aerospace industry. A growth rate of 4.5 percent per annum is assumed for the period 1988 to 1995 and 3.5 percent in the later years of the forecast.

Figure 33 presents the forecasts in Scenario #3, the moderate growth projections.

An additional 2,260 skilled people will be needed in the British Columbia aerospace industry to meet the forecast requirement. Another 1,100 aircraft maintenance engineers (AME's) are included in the total skills requirement. Over the 12-year period of the forecast, this represents an additional 190 skilled people needed each year by the aerospace industry. The annual AME requirement is 92 people.

7.2.4 Scenario #4: High Growth

The high growth forecast incorporated in Scenario #4 assumes that the existing aerospace industry will continue to grow at 4.5 percent per annum between 1988 and 1995 and at 3.5 percent per annum in the remaining years of the forecast. In addition, it is also assumed that several "special initiatives" are undertaken to significantly improve the aerospace industry. These "special initiatives" provide a "quantum leap" for the industry to become of significant size and to establish British Columbia as a major air carrier and aerospace manufacturing centre.

These initiatives take advantage of British Columbia's strategic trade and commerce links with the Pacific Rim. These links were described in an earlier section.

Figure 34 shows the results of the forecast in Scenario #4.

From the figure, the growth rate, with the addition of the "special initiatives", rises to 6.1 percent for the period 1988 to 2000.

Maintenance Personnel Growth Forecasts
Status Quo

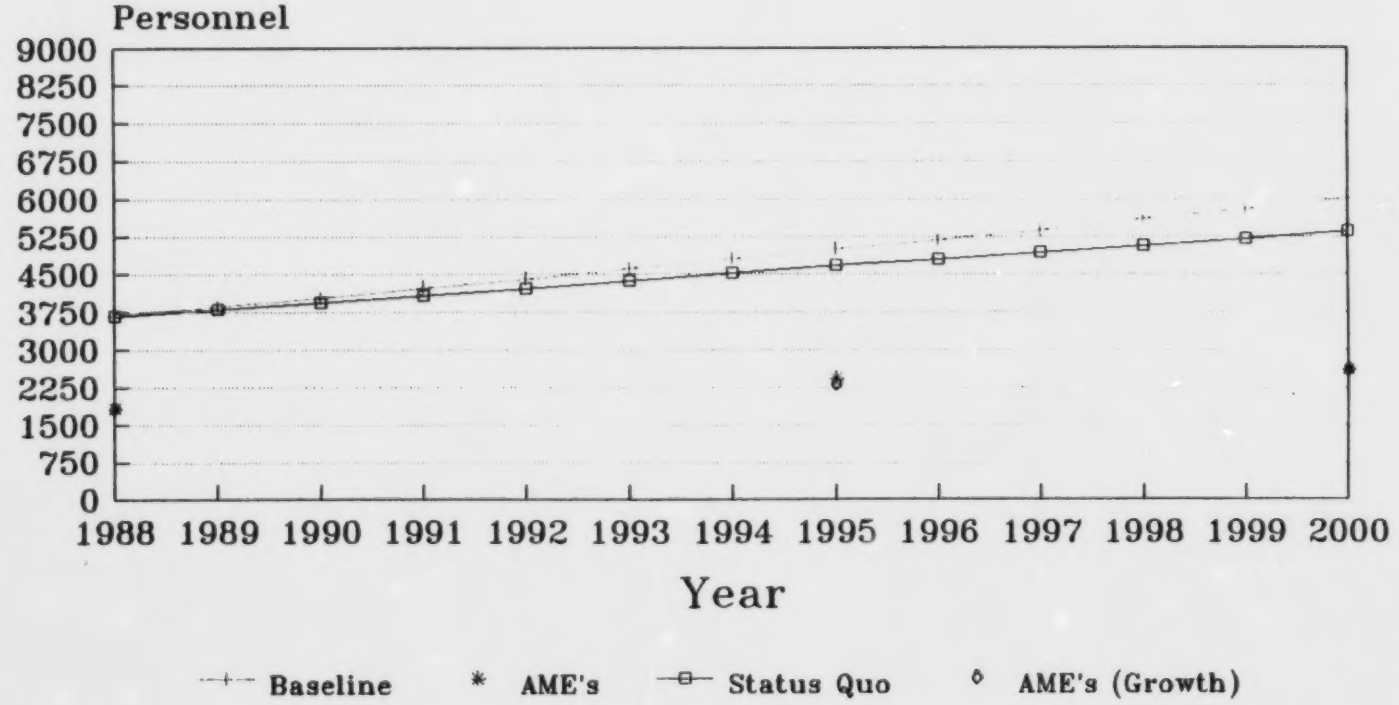

Figure 32

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Maintenance Personnel Growth Forecasts
Modest Growth

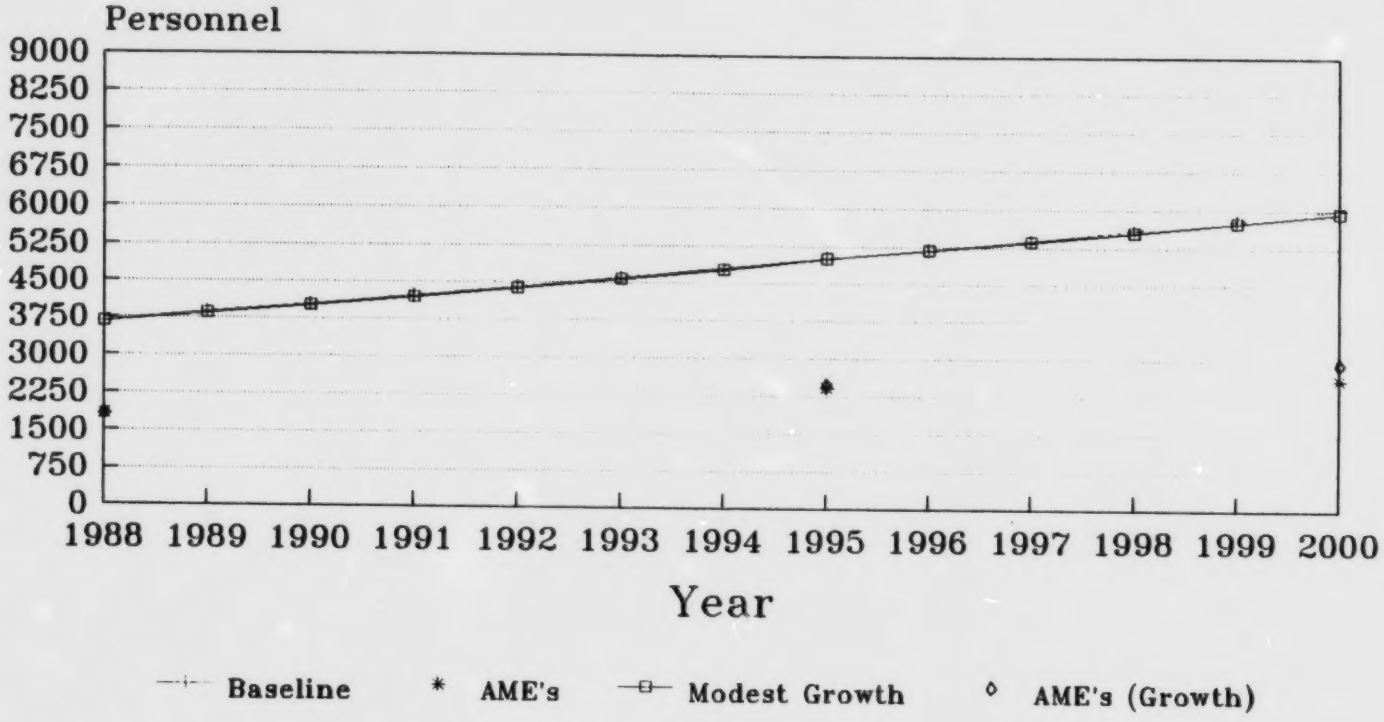
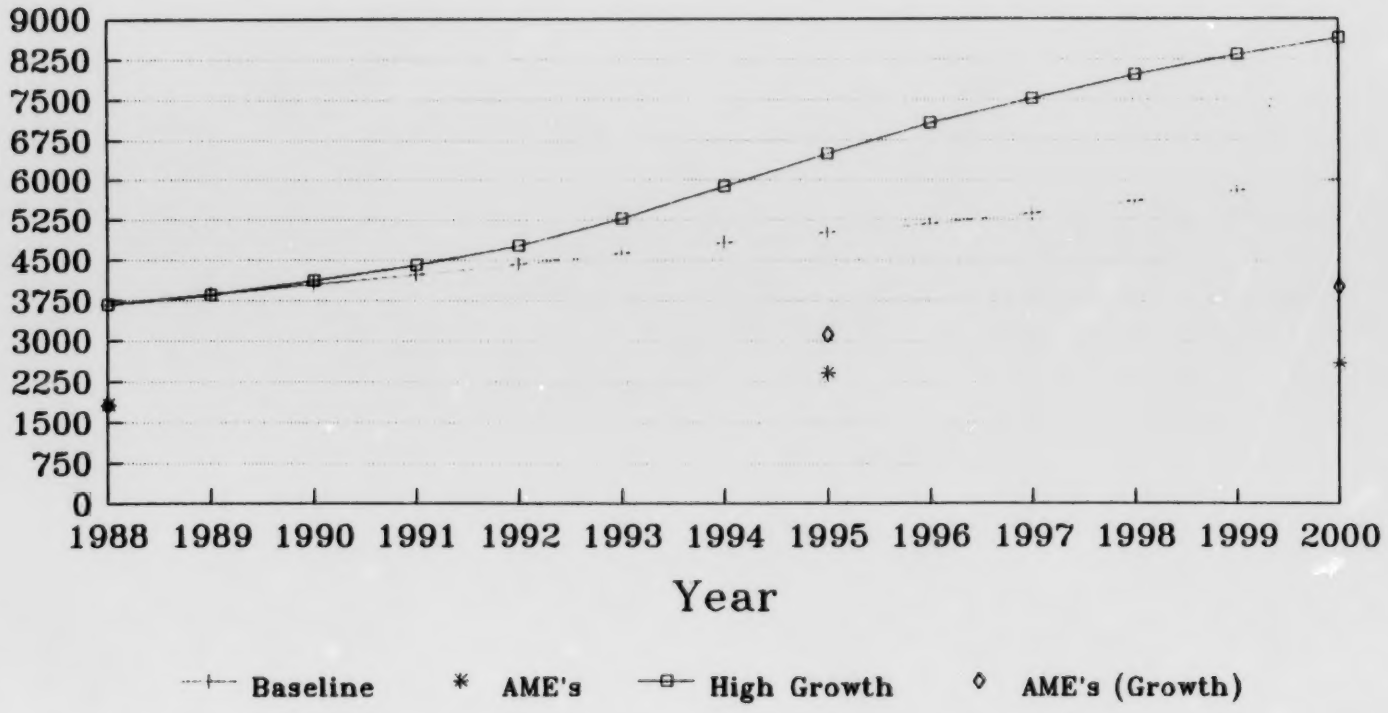


Figure 33

McNeal & Associates
July 1989

Maintenance Personnel Growth Forecasts
High Growth



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July 1989

Figure 34

By 1995, there are 1,485 additional skilled workers in the province than the total expected by the aerospace industry itself. The forecast also predicts an additional 650 AME's in the total skilled personnel requirement.

The year 2000 sees some 2,905 additional skilled workers than even the industry itself has anticipated. This figure includes some 1,100 AME's.

The figure also notes that the total skilled employment level reaches 8,625, more than double the 1988 level of 3,663. Each year an additional 410 skilled workers will be needed to meet the forecast requirements. There could be a requirement for 180 new AME's each year of the forecast.

7.3 Aerospace Labour Impact

The British Columbia Government has identified the aerospace industry as one of the four technology industries to promote to take advantage of the industries' technology benefits, including their export potential. In addition to aerospace, electronics, undersea technology and value-added forest products are the other industrial sectors being promoted.

To realize the technology benefits from aerospace products and services, however, there has to be an adequate supply of skilled labour. The skilled labour workers have to be trained in advanced technology processes. They have to have the experience to provide a high standard of products and services. The aerospace industry, as pointed out, is now a global business. Without skilled workers, the British Columbia aerospace industry cannot effectively compete for existing and future aerospace opportunities. There are worldwide shortages of certain skilled aerospace people. Those areas which have an adequate supply of skilled labour now have an advantage over others. They will attract the aerospace opportunities. The gap will widen in the 1990's as the demand for aerospace products and services expands.

7.3.1 Current and Future Impact on the Economy

In a previous section, it was pointed out that the Canadian aerospace industry earned a total of $12.4 billion in 1988. This represents earning for the combination of air carriers and aerospace manufacturing firms. The total employment of the industry is nearly 108,000, generating some $3.5 billion in wages for the Canadian economy.

In the British Columbia aerospace industry, about $1.2 billion is directly generated by the air carriers (principally Canadian Airlines International) and some $80 million by aerospace manufacturers. Total direct employment is estimated to be over 12,000, generating some $430 million in wages and salaries. Including indirect and induced revenue generation raises the economic impact to $3.6 billion and generates employment of over 41,000.

It is estimated, from the industry survey, that the British Columbia aerospace industry employed some 3,663 skilled labourers in 1988. Over half of these labourers were employed by Canadian Airlines International. Out of the total skilled labour pool, some 1,800 in British Columbia hold Transport Canada licences to conduct aircraft maintenance as aircraft maintenance engineers (AME). It is estimated that these skilled aerospace workers generated some $115.0 million in wages and salaries in 1988. This represents over 25 percent of the total for all aerospace employees working in the province. Assuming a provincial economic multiplier of 2.0, where for every direct worker in the industry another worker is supported, the total employment generated by skilled aerospace workers is 7,300 and the wages earned are over $230 million.Skilled aerospace workers are important to the provincial economy.

A series of scenarios to illustrate the range of forecasts for the future demand for skilled aerospace labour was developed earlier. Each of these scenarios has a different impact on the regional economy. Those forecasts with low growth rates indicate limited demand. Therefore, the economic impact is reduced for future jobs and wages. Those forecasts which illustrate high growth, on the other hand, show increased demand in the province for skilled labour. Hence, there is an increased positive economic impact.

To compare the scenarios as to their relative impact on the British Columbia economy, Scenario #3, Modest Growth, was chosen as the bench mark scenario. It incorporates an expectation that British Columbia will keep pace with the growth expected in the world aerospace industry. Using this scenario as a bench mark allows comparison of the employment and wages gained or lost under the alternative scenarios.

Table S, overleaf, summarizes the forecast economic impact of each of the four scenarios for both 1995 and 2000. Economic impact is expressed in employment and wages.

Scenario #4 (High Growth) produces the highest economic benefits for employment and wages. In 1995 this scenario generates 1,485 more jobs that the bench mark scenario and $46.0 million more in wages. By 2000, Scenario #4 creates 2,705 more jobs than the bench mark scenario and $82.9 million more in wages.

Table S

FORECAST ECONOMIC IMPACT SUMMARY
1995 AND 2000

	EMPLOYMENT		WAGES (million $)	(million $)
	Skilled Jobs (incl. AME)	AME Jobs	Skilled Jobs (incl. AME)	AME Jobs
		1995		
SCENARIO #1	3,450	1,700	108.5	61.2
SCENARIO #2	4,660	2,300	146.5	82.8
SCENARIO #3	4,985	2,450	156.6	88.2
SCENARIO #4	6,470	3,100	202.6	111.6
		2000		
SCENARIO #1	3,670	1,800	115.3	64.8
SCENARIO #2	5,340	2,600	167.5	93.6
SCENARIO #3	5,920	2,900	185.9	104.4
SCENARIO #4	8,625	4,000	268.8	144.0

AME wages calculated at $36,000 per annum (1988 dollars)
Other skilled wages calculated at $27,000 per annum (1988 dollars)

* Note: Does not take into account attrition of existing skilled manpower

The negative growth scenario, Scenario #1, is obviously the worst case scenario for future economic impact. In 1995, it has 1,535 fewer skilled jobs than the bench mark scenario. There is also $48.1 million less in wages. By 2000, the gap widens with 2,250 fewer jobs in Scenario #1 and $70.6 million less in wages.

The status quo, Scenario #2, also results in a reduced economic impact, which reveals that the British Columbia aerospace industry cannot afford to stand still if future skills jobs are to be created and wages earned for the economy. In 1995, Scenario #2 has 325 fewer skilled jobs than the bench mark scenario and $10.1 less in wages. By 2000, some 580 fewer skilled jobs are evident and $18.4 million less in wages than the bench mark scenario.

The modest growth scenario, Scenario #3, projects that skilled employment will increase from the 1988 figure of 3,663 to 5.920 by 2000. Wages of skilled workers are expected to increase from $115 million in 1988 to $185.9 million (1988 dollars) by 2000.

The modest growth scenario, Scenario #3, projects that skilled employment will increase from the 1988 figure of 9663 to 5920 by 2000. Wages of skilled workers are expected to increase from $115 million in 1988 to $185.9 million (1988 dollars) by 2000.

7.3.2 Labour Shortage Impact

The British Columbia aerospace industry is now experiencing shortages of skilled workers. The industry survey reveals that sheet metal and composite structure tradesmen are scarce as are avionic technicians and experienced aircraft maintenance engineers. Aerospace firms are actively recruiting across Canada, Europe, Asia and the Middle East, looking for experienced personnel. The industry survey indicated that the shortage of skilled labour will become acute as many experienced workers reach retirement age and as the demand for aerospace products and services continues to grow. The major air carriers, in particular, are expected to feel the impact of skilled shortages since about 30 percent of their skilled workers are now over 46 years of age.

The shortage of skilled aerospace workers can have a negative impact on the British Columbia economy. If adequate skilled personnel are not available to meet the needs of industry, current aerospace activities will be affected, let alone the future opportunities which may become available for the industry. Without skilled people additional projects cannot be taken on by the aircraft maintenance firms and aerospace manufacturers.

The previous sub-section summarized the future economic impact of the range of forecasts presented for jobs and wages. Skill shortages will impact on the ability of some of the scenarios to be realized. Even the "modest growth" Scenario #3, which the industry predicts for its own growth, is in jeopardy without skilled people. The "high growth" Scenario #4 is not possible without having access to additional skilled people. Hundreds of jobs and millions in wages are at stake without having an adequate pool of trained people.

In addition to the potential loss of jobs and wages, there are other losers in the British Columbia economy. The federal and provincial governments lose the potential tax revenue from the additional employment and corporate revenue. Municipalities lose on the potential from property taxes and the expansion of their industrial base. The individual companies lose potential revenue from their customers and the erosion of their customer base. More importantly, however, is that the aerospace industry, as a whole, loses. The industry will not be able to take advantage of new opportunities such as those "special initiatives" outlined. These new opportunities generated by "special initiative" are needed to develop the industry linkages to build up

to a critical size. An increase in size will not only assist the industry in being more competitive on a global basis but will also allow the industry to broaden and diversify into other types of aerospace products and services.

Many of the aerospace opportunities are linked to Pacific Rim initiatives. They will not be fulfilled to strengthen our trade and commerce ties. The situation is critical. Now is the time for British Columbia to position itself for an important role in the Pacific Rim economy. To take advantage of Aerospace opportunities, however, the skilled people have to be available. If shortages are now evident and are expected to increase in the future, action must be taken now to solve the skilled shortage problem. The British Columbia economy cannot afford to wait.

8.0 SKILLED WORKERS

Availability of skilled aerospace workers is identified as a key criterion to achieving future aerospace opportunities for the British Columbia aerospace industry. It is important to understand what is happening with skilled labour in the aerospace industry and other industries and to seek solutions to increasing the number of skilled workers needed by the aerospace industry. This section discusses these factors.

8.1 Technology Factors

Technology has demanded that new skill areas be introduced into the aerospace industry. Computer based technology has been one area of very dramatic technological changes. CAD/CAM has been introduced into aerospace engineering and manufacturing. CNC machinery is now common in aerospace machine shops. Automated systems monitoring and inspection, as well as built-in test equipment (BITE), is commonplace in new aircraft. Also commonplace are digital buses, data links, and other computer-related systems. In the last few years, terms like "fly-by-wire," "glass cockpit," "lithium-aluminum," "Kevlar," and "radar imaging" have been introduced. Each of these new technologies has meant changes in the way processing, repairing, and servicing are done and new skills have to be also introduced. It has also meant that some skills are becoming redundant. Fabric repairs, hand tooling, tube-type avionics, mechanical rigging and other skills are no longer in demand or have become redundant.

Related to technology changes have been significant changes in quality assurance to improve product quality and safety in the industry. International Civil Aviation Organization (ICAO) aircraft maintenance standards have changed, requiring high standards of training and knowledge as well as experience. Similarly, the U.S. Federal Aviation Administration (FAA) standards for A&P licences under FAR 121 and 135 have been altered. Transport Canada has revised its Airworthiness Manual and will change the AME licensing system (Personnel Licensing Handbook). The AME rating designations will change from "A" and "P" to "M" (groups 1-20), "E" (groups 21-23), former "B" licence to "S" (groups 31-34), and former "D" and "P" to "P" (groups 41-44). Relevant Air Navigation Orders (ANO's), which impact on maintenance, are being changed. A new Aircraft Maintenance Engineer log book is being introduced to record certification and experience. These changes will result in some new skills being needed such as computerized maintenance and inventory records.

Technology changes and regulatory standards are key factors in acquiring new skills in the aerospace industry.

8.2 Changing Skill Requirements

Clearly, aerospace employers must find some solution to the shortages of skilled workers if the industry is to continue to grow. One way in which many of them try to do so is by recruiting outside the country. This solution to remedy skilled labour shortages has, however, become increasingly difficult to exercise. Over the period 1984 to 1987, the numbers of immigrants coming into Canada who reported high-skilled technical occupations as their intended occupation were small. This situation reflects the increasing standards of living and buoyant economic conditions in those countries from which Canada has traditionally drawn many of its skilled workers in the past, as well as tighter Canadian immigration quotas. Both factors are making it increasingly difficult to recruit workers abroad. Foreign recruitment is not a long-term viable solution to solve skill shortages.

Another reason for the shortage of workers in many high-skilled technical occupations is that training opportunities to develop these workers depend, to an important extent, on employers' training initiatives. These training initiatives tend to be sporadic and vary with the crests and valleys of business cycles. For example, apprenticeship training programmes are in important source of qualified workers for skilled trades. The amount of apprenticeship training provided by employers is adversely affected by the business cycles. During economic downturns, apprentices are usually among the first workers laid off because of seniority rules. Their training is put on hold, thereby reducing the supply of skilled workers in the longer term. Also, new training opportunities do not come open during a period of economic downturn. Consequently, when the economy does move from recession into a period of economic growth, employers quickly begin to experience recruiting problems in occupations for which apprenticeship training is an important source of supply.

Since the training programmes for many of the aerospace trades are four or five years in length, a long-term decline in intake during an economic recession means that the supply of skilled workers from the apprenticeship programme continues to decline during the first few years of economic expansion. This makes the skill shortage problem an even more difficult one.

8.3 Implications of Technological Change for Literacy

The increasing pace of technological innovations has important implications for the basic skills possessed by existing members of the aerospace labour force and by new entrants. The successful introduction of new technologies into the industry frequently requires that workers possess a good command of basic skills - reading, writing, mathematics, and communication and interpersonal skills. To understand how new technology works on the shop equipment, these basic knowledge skills are needed. In a recent study, the Canadian Business Task Force on Literacy makes several key observations. These observations are:

- Jobs requiring a low level of skill are at risk for displacement from the introduction of hard and soft technologies. Hard technologies include automated warehousing, computer-assisted manufacturing and robotics. Soft technologies include semi-autonomous work groups, which may require fewer numbers of workers.

- The new technologies are affecting the types of skills workers must have. For example, computer-based technologies require levels of comprehension and ability above those previously required.

- As responsibility for the quality of production is being decentralized to the level of the work station, workers are increasingly required to operate in monitoring, controlling and analytical modes.

- New technology is requiring that individuals on the shop floor be more literate than they were in the past. They must be able to read instructions, diagnose problems, input numbers and read from operating materials. They must be able to communicate problems with their fellow workers and use analytical thinking to arrive at solutions.

- The basic skill levels required for entry-level positions are rising. Many firms now require a minimum of Grade 12 education for entry-level positions.

- Upgrading and training are becoming crucial in most industries. School-leaving illiterates are in an increasingly vulnerable position if they are unable to comprehend this training.[15]

Illiteracy could pose problems for the aerospace industry. The Canadian Business Task Force on Literacy spelled out some of them: lower productivity, excessive supervisory time, increased health and safety risks, inconsistent product quality, lack of trainability, poor employee morale, and greater direct training costs to firms who must upgrade their employees. It is estimated that illiteracy costs Canadian corporations about $10.7 billion a year through lost productivity, industrial accidents, direct leaving costs, lost earnings, unemployment expenses, and adult education costs.

Young people who enter the labour force ill prepared to compete for jobs in a technologically advanced society pose serious problems for themselves and society. Without a good command of basic skills and the minimum of a high school diploma, the new entrant will be relegated to the lowest paying and

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[15] Business Task Force on Literacy, Measuring the Costs of Illiteracy, Toronto, February 1988.

least desirable jobs. In an internationalized global economy, goods can be produced wherever production costs are lowest, often in developing countries. Similarly, it is possible for sophisticated service activities to be carried out in any industrialized society. "The key competitive variable will become the quality of the work force, that is, the level of knowledge, skills, adaptability, ingenuity and motivation possessed by the people in any given society."[16]

From the results of these studies, the conclusion is inescapable. The evolving occupational and skill requirements of the economy mean that greater attention has to be paid to higher levels of educational attainment and to the acquisition of basic skills by existing and future members of the labour force. As the profile of the labour force continues to shift towards the older age brackets and as technological change continues to take hold, the ability to engage in continuous learning will become a necessity for most workers. The British Columbia aerospace industry must be cognizant of these fundamental changes taking place and the role education takes to help adapt employees to changes.

8.4 Implications for Skills Development and Training

The evidence presented makes it clear that technological innovation significantly affects the occupational mix and the skills that workers require to carry out their jobs. Occupational shifts are occurring in the economy as the service sector continues to increase its share of total employment and as the pace of technological innovation accelerates in both the service and goods producing sectors. The shift from blue-collar to white-collar employment is expected to continue. In the manufacturing sector, high-skilled technical jobs will grow in importance. Low-skilled and semi-skilled jobs will decline. Consequently, a greater investment in education and training will be required as the demand for more highly trained personnel increases. This is true as well for the aerospace industry.

Technological change is also having a significant impact on the skill sets workers require.[17] Although there is evidence of some de-skilling, with consequent displacements and shifts to part-time work, the more predominant trend is multi-skilling. Most firms surveyed by the Ontario Task Force on Employment and New Technology expect that workers will need more skills and more training to achieve proficiency in their jobs. There is also a strong consensus that good basic skills in reading, writing and mathematics and interpersonal and communications skills are becoming much more important for all workers because of the introduction of new hard-process technologies. Innovations in workplace organization similarly require an increase in the

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[16] Business Task Force on Literacy, op. cit.

[17] Ontario Task Force on Employment and New Technology, Employment and New Technology, Toronto, Government of Ontario, 1985.

skills of workers. They must become more proficient in problem-solving and team work as responsibility is shifted from the individual worker to working groups or work stations.

There will be an increase in the use of automation technology in the immediate future, and a shift toward greater utilization of process technology is foreseen for the next several years, a shift that has important implications for skills development. It will require placing a higher priority on technology-driven training, with the number of employees using robots, automated inspection and quality control, and computer-aided design expected to more than triple over the 1985-1990 period. The aerospace industry will experience these effects more than some other industries.

A greater diffusion of process technologies will require more training. This training tends to be complex. Often, it involves a mixture of classroom and on-the-job training, rather than on-the-job training alone. Aerospace process technologies reflect these complexities.
Employers will be called on to make a greater investment and commitment in training in response to the increased introduction of process technology and more sophisticated automation systems. In assessing the adjustment of workplaces to the introduction of office automation over the past several years, the Economic Council of Canada observed "most innovating establishments appear to be adjusted to changing labour requirements without serious problems - even though a large percentage of the firms that had adopted technology over the 1980-1985 period indicated that it had resulted in the creation of new jobs or substantially altered existing ones."[18] This finding is attributable to the importance placed on training by these companies to facilitate worker adjustments. Retraining is the adjustment mechanism most often chosen by firms for dealing with the impact of technological change is supported by an Ontario Manpower Commission study conducted in 1986, which found that about 90 percent of the establishments which had recently experienced changes in staffing arrangements because of technological change, had used on-the-job training to help employees acquire the skills they needed to work with the new equipment or processes.[19]

Over the next several years, with the increased use of process technology, which will largely affect workers on the shop floor, retraining is expected to become longer, more formal, and more structured in nature. This calls for an even greater commitment to workplace training by employers.

The heightened scale and complexity of technological innovations foreseen will require aerospace employers to make a substantial financial investment in training. Without these investments in training, aerospace employers will

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[18] Economic Council of Canada, Innovation and Jobs in Canada, Ottawa: Supply and Services Canada, 1987.

[19] Ontario Manpower Commission, Training In Industry: A Survey of Employer Sponsored Programs in Ontario, Toronto, 1986.

encounter substantial difficulties in investing in the new forms of technology that will be needed for survival in a competitive marketplace. As noted in an article: "One factor that determines the long-term profitability of any company is its willingness to adopt new technology. Another is a company's ability to harness and adapt technology in the workplace. The challenge is clear - to manage these two factors carefully."[20]

8.5 Sources of Skilled Workers

This sub section addresses sources for obtaining skilled workers. It examines, in particular, those job categories which are experiencing shortages of skilled workers, or which are expecting to experience shortages during the forecast period. The traditional sources of skilled workers are:

- Immigration from traditional sources of skilled workers, e.g. United Kingdom, Germany, U.S. Because of factors of full employment and high wages in these countries, recruitment in those areas can be expected to provide less than 5 percent. West Germany, France and Scandinavia pay as high as $60 U.S. an hour for some aerospace skills. Canadian immigration policy will also restrict foreign recruitment.

- Immigration from non-traditional sources, e.g. Middle East, Hong Kong, Singapore, can be expected to provide another 5 percent. Asian sources have provided some of the foreign recruitments in the recent past. Expatriate skilled workers in the Middle East coming off short-term contracts are being sought by Canadian Airlines International.

- Migration from other provinces, e.g. Manitoba, Ontario, Quebec, or the U.S., where there are "large aerospace centres" could supply as much as 23%. However, there could be a negative flow to these areas depending on the aerospace activity from time to time. British Columbia workers could be attracted to other aerospace regions in North America. The nearby Boeing plant in Everett and the new Heath-Tecna fabrication plant in Bellingham, Washington are both hiring skilled workers and could draw British Columbia workers from the province.

- Ex-military personnel are no longer a large source of skilled labour. Short-term commission military personnel do not have the overall qualifications the civil industry requires. The longer serving, more qualified personnel stay in the service as a career (e.g. TQ-5). In addition, due to recruitment and

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[20] "Automation: A Mixed Blessing for Many Firms," The Globe and Mail, January 4, 1988.

budgetary constraints, DND are passing more of their overhaul and repair responsibilities to private industry.

In addition to traditional sources of skilled labour, the following will also have to be examined as possible sources of future skilled workers:

- Recruit skilled workers from other industries which have transferrable skills needed by the aerospace industry, such as electronics and computer programming.

- Worker exchange programmes with other aerospace industries in other regions. Boeing, for example, is currently using some 700 experienced Lockheed-Georgia personnel (average 10 years' experience) who came off the B-1 bomber programme. Boeing has also borrowed workers from its own Wichita, Kansas military plant and the Boeing-Vertol helicopter plant in Philadelphia, Pa. Bristol, in the United Kingdom, has 1,000 skilled workers who have been recently laid off due to reductions in defense contracting activity. The company is interested in exchanging these employees.

- Retraining and/or enhanced education of the existing labour force to obtain the necessary qualifications is another possible source of skilled workers. Retraining will become a necessity to ensure that workers have the necessary technical skills to meet new standards. Retraining has been identified by other industries as a key source of skilled workers. The aerospace industry will soon have to follow the lead of other industries and earnestly start to retrain its existing employees to higher skill levels.

- Another source of skilled people is to increase ab initio training at aviation training centres. Additional physical capacity is available at Western Canadian vocational schools but additional instructors and equipment are needed to handle increased enrolment. These schools will be a very important source of skilled workers.

- A revised apprenticeship programme has considerable merit as a source of additional skilled people for the British Columbia aerospace industry. A solid apprenticeship programme is likely the best solution to providing the number of skilled employees needed to meet forecast demand. An apprenticeship programme needs to be recognized by both federal and provincial authorities and it requires long-term funding commitments by both government and industry. An apprenticeship programme could accept those which do not necessarily meet the vocational schools' academic entrance standards but who have aptitude for the aerospace industry. Specific courses could be provided by the vocational

schools for these apprentices on various subjects, each with a certificate. Opportunities would be available to also allow these apprentices to improve the basic knowledge skills over time. The industry with a scedule co-ordinated with the vocational schools would provide on-the-job training.

8.6 How Others Are Solving the Problem

There is a world-wide shortage of trained aerospace workers as noted in an earlier section. Only a few aerospace jurisdictions have developed programmes to cope with skill shortages but most rely on others to provide the trained people.

In North America, Piedmont Airlines and Eastern Airlines did, at one time, have their own maintenance training schools. Many airlines also had apprenticeship programmes but dropped these in the early 1980's. Northwest Airlines has recently started a pilot training school with the Centre for Aerospace Science at the University of North Dakota which provides FAR Part 147 training. It is contemplating adding maintenance training. There are 150 A&P vocational schools in the U.S. but only six schools are graduating more than 100 A&P students a year. Embry-Riddle Aeronautical University in Daytona, Florida, Pittsburgh Institute of Aviation, Colorado, Aerotech of Broomfield, Colorado, Parks College of St. Louis University in Cahokia, Illinois and the New Tech Aviation Career Centre in Oklahoma City are perhaps the best known. The U.S. has an Aviation Technical Educational Council which is similar to the Canadian National Advisory Council (NAC). The U.S. largely has the same problem as is being experienced in Canada.

Singapore Engineering, in co-operation with the government, operates a programme to ensure high school graduates are provided aerospace training to meet the needs of Singapore's fast-growing aerospace programme. HAECO has a similar programme in Hong Kong.

Australia's airlines had an apprenticeship programme, but let it lapse in 1980. Australia is now desperate for skilled people.

In Europe, the United Kingdom did have an extensive aerospace apprenticeship programme but the programme was dropped in the late 1970's. The journeymen who were trained under the apprenticeship programme were a prime source of skilled labour for the Canadian aerospace industry in the 1960's. They are considering re-establishing the apprenticeship programme.

In both the Netherlands and West Germany there are well-developed programmes to foster trained aerospace workers.

The Netherlands programme is directed through two schools. The University of Delft trains those students for the engineering profession in the aerospace industry. The Anthony Fokker School in The Hague trains trade and technical people. The integrated training programme involved the needs of

the Dutch Air Force, KLM Royal Dutch Airlines and the Fokker Aircraft Company who manufacture aircraft. These firms, with the schools, provide on-the-job training and the apprentice standards.

A similar training/apprentice programme has been operated for over 20 years by Lufthansa German Airlines. At their Hamburg maintenance centre, the airline provides its own intensive classroom and on-the-job training. Workers are hired with no experience directly from German high schools and enroled in the training programme. Depending on the aptitude of the employee, various career paths are available. The employee could be directed into aircraft maintenance, avionics, structures and other skill categories. There is sufficient flexibility in the programme to allow an employee to proceed to obtain an engineering degree in aerospace technology.

9.0 AEROSPACE TRAINING

One of the principal sources for current and future skilled aerospace workers is based on improved aerospace training. Both public and private institutions now provide aerospace training as well as the individual aerospace companies themselves for their employees. The manufacturers of aerospace products and equipment also provide customer employee training to varying degrees. The training which is provided is both structured with regular classroom or home study tuition or instructional on-the-job training. To meet the skill level needs which have been identified, training must be significantly expanded, both in the number to be trained and the scope of the training offered. This section examines aerospace training options as a means to obtain the needed skilled workers.

9.1 Aerospace Training Centres

There are eleven Canadian aerospace training centres which are supported by their respective provincial governments and are approved by Transport Canada. About 350 students graduate from these vocational training schools each year. The aviation training programmes are designed to provide credit towards an AME license. The approved schools include the following:

- Central Newfoundland Community College - Gander, Newfoundland
- New Brunswick Community College - Moncton, New Brunswick
- CEGEP Edouard Montpetit - St. Hubert, Quebec
- Centennial College - Scarborough, Ontario
- Seneca College - North York, Ontario
- Central Technical School - Toronto, Ontario
- Canadore College - North Bay, Ontario
- Confederation College - Thunder Bay, Ontario
- Southern Alberta Institute of Technology - Calgary, Alberta
- Northern Lights College - Dawson Creek, BC
- British Columbia Institute of Technology - Richmond, BC

These approved training schools formed an association of aviation training schools to ensure common training methods. This decision was reached at the latest National Advisory Committee (NAC) meeting held at Canadore College in June, 1989.

In addition to these Transport Canada approved schools, Stevenson Aviation Technical Training Centre - Winnipeg, Manitoba, John Abbott College - Ste. Anne de Bellevue, Quebec, Northern Alberta Institute of Technology - Edmonton, Alberta, and Camosun College - Victoria, BC offer specialized aviation trades training. They also will assist local industry by offering company specific training courses (e.g. Camosun College with Viking Air is training 14 sheet metal personnel). Stevenson Aviation Technical Training for the past few years has offered a Transport Canada approved apprenticeship

programme. To date, the programme has not been a success with only six graduates. It is expected that some of these schools could become *approved* schools in the future.

The following profiles the three approved vocational training schools in Western Canada:

9.1.1 Southern Alberta Institute of Technology (SAIT)

SAIT has its aviation programme located at its main campus in suburban Calgary. Its facilities allow instruction on several aircraft types within the building, including a Beechcraft Kingair, helicopters, and light twin and single engine training aircraft.

The school graduates some 45 students a year but has the capacity to handle 60. The school provides instruction for both fixed and rotary wing mechanics, avionics and structure repairs. It attracts its students principally from Alberta but graduates leave to join firms all across Canada. The entrance requirements are high school graduation with 70 percent or better in English, Math and Physics. An entrance exam is also written by the student applicants. The courses and curricula offered follow Transport Canada criteria. Currently the two-year course requires 1,800 hours of instruction and will likely be increased to 2,400 hours based on discussions with Transport Canada.

The staff has recent industry background. Most were recruited from corporate aviation departments when the recession impacted the petroleum industry in the early 1980's. SAIT works closely with the local aerospace industry, particularly Canadian Airlines International and Time Air to offer special training courses from time to time depending on short-term needs of the industry.

9.1.2 Northern Lights College

In the fall of 1980 the Occupational Training Council granted approval for an aircraft maintenance engineering programme to be offered at Northern Lights College in Dawson Creek. The Ministry of Education started funding the programmes in September 1981. It has also funded a rotor technology programme which began in September 1986.

The aircraft maintenance programme has been increased from 1500 hours to 1800 hours to meet Transport Canada requirements. The school anticipates that in 1993 a 2400 hour requirement will be instituted. The 1800 hour programme now requires 15 months to complete the training. The experience gained is accepted as 18 months experience credit towards an AME licence. Either "A" or "R" category training is provided. The school graduated two classes of 32 students this year in the aircraft maintenance engineering programme. Approval has been granted to start a third class of 16 students beginning in

January 1990. There are approximately 120 students waiting to be accepted for the programme.

The rotor technology programme provides advanced training in the maintenance and repair of helicopters. There are six core training modules. Completion of all six modules is credited as 9 months' experience towards an AME "R" category licence.

Short courses on basic composite repairs and electrical training are offered. Also offered are Transport Canada approved *type* courses for Bell 206 and Aerospatiale 350/355 helicopters. There were 12 graduates in the rotary technology programme this year. In 1988, there were 30 students on the Bell 206 *type* course and 24 on the Aerospatiale 350/355 *type* course.

Northern Lights College has several aircraft in its inventory including the twin engine turbo Aero Commander and Piper Aztec. It also has a Bell 206 and Aerospatiale 350 A Star. The school also has two Allison 250 turboshaft helicopter engines.

Northern Lights College is a member of the National Advisory Committee (NAC) which makes recommendations to Transport Canada about training and licensing of AME's. The school also has an industry-based Program Advisory Committee to assist the school in developing its curriculum and training techniques.

9.1.2 British Columbia Institute of Technology (BCIT)

BCIT is one of the largest aviation training centres in Canada in both the number of graduates (120 a year) and the facilities and equipment. Technical training for maintenance personnel was started by the then Pacific Vocational Institute in 1957 in temporary facilities at the Pacific National Exhibition grounds. BCIT operates from a separate building located at Vancouver International Airport, some distance from the main campus in Burnaby, B.C.

BCIT, in 1986, acquired its training facility from PWA Corporation. PWA Corporation had transferred their airline operation to the former CP Air building at Vancouver International Airport. BCIT, since 1977, however, has operated separate, limited size aviation training facilities at the airport. The new complex includes a very large concrete hangar, large enough to accommodate a Boeing 707, workshops, classrooms and offices. It has several aircraft available for instructional purposes, including a turboprop airliner, business jet, training aircraft and several helicopter types. It also has several demonstrator piston, turboprop and turbojet engines.

BCIT offers an approved Transport Canada aviation instruction programme in fixed and rotary wing aircraft maintenance. It also offers an avionics and a structures programme. Currently there are 99 aircraft maintenance students, 27 avionics students and 14 structure students enroled. The class sizes vary between 22 and 34. The capacity is 178 over four complete three month semesters. In addition to its approved aviation programme, it operates

as a night school offering various aviation subjects and running special courses for industry when requested. A composite structure course for Canadian Aircraft Products was recently held for 70 employees).

Entrance requirements are high school graduation with emphasis on Math and Physics courses. BCIT, however, will offer remedial instruction to those students who need up-grading. This will help the students to understand instruction in courses needing Math and Physics. BCIT currently has a waiting list of two or three years before space is available in the aviation programme. The enrolment could be increased by adding instructors and offering afternoon courses. Additional equipment would also be needed if an afternoon class were added. It is estimated another 60 students could be enroled. Staff members have an industry background and most have several years of instruction experience.

9.2 Training Institute Changes

Interviews with the vocational training institutes indicate that the training institutes are undergoing fundamental changes in their aviation programmes. All are attempting to be more responsive to industry demands. They find it difficult, however, to define long-term needs of the industry. These needs must be defined so curriculum and courses can be planned to obtain the necessary instructors, equipment and funding to conduct the programmes. Courses have been started, based on industry requests, only to find that industry needs had changed. The students, as a result, are disappointed that hiring did not take place after graduation. The training institute is also reluctant to offer future industry courses on speculation unless commitments are made by the industry.

Transport Canada is taking an increasing role in the development of courses and curriculum taught at the approved schools. It will also implement increased instructional hours for an approved programme. A student will be required to attend 2,400 hours of instruction. Recent changes to the Personnel Licensing Handbook (PLH) require that as of January 1990, applicants for an AME license must take structured training. The need for compulsory structured training will put additional demands on the vocational schools. Approved schools will have to have a Transport Canada approved Training School Manual. This manual will be similar to an air carrier operations or maintenance manual. It will outline what will be taught at the school, the type of equipment used, the instructor qualifications, and other standards which must be Transport Canada approved. Increased emphasis will be placed on keeping student records about specific courses taken, time on the course, classroom and workshop time, and the ratio of students to instructors (15:1 maximum in classroom). AME's and AME candidates will be issued new log books which will record training, endorsements and on-the-job experience. By setting AME standards, Transport Canada is establishing vocational criteria for AME qualifications. Vocational schools offering an approved aviation programme will have to adhere to the criteria outlined in their new Training School Manual.

9.3 Training Institute Funding

Funding is an important issue with all training schools and the students. There are not sufficient funds available to offer additional courses, to hire instructors or to purchase training equipment and supplies. Provincial governments are responsible for education and, therefore, training. In British Columbia, it is the Ministry of Advanced Education and Job Training which is responsible for providing the money to maintain and operate the aviation training schools at BCIT and Northern Lights College. The Ministry is responsible for funding other vocational schools, colleges and universities in the province. All desire additional monies for their respective needs. Allocation of scarce resources towards advanced education by the provincial government, therefore, becomes complex and involves several ministries and agencies in the process. Often, money is only available to maintain the existing condition. Limited funds are currently available for expansion of aviation training programmes.

There are federal re-training and up-grading funds available for certain identified job categories in which shortages are being experienced. The national *Human Resources Study of the Canadian Aircraft Maintenance Industry* is designed to assist in determining specific skill shortages so training assistance can be provided.

Students, as well as the vocational schools, are vitally interested in educational funding. Increasing the length of approved training courses also increases the financial burden of attending an aviation training programme. Programmes which were completed in 1,500 hours now require 1,800 hours and will be increased to 2,400 hours in the future. The increase in instructional hours is based on a demand by the industry to have more experienced people and by Transport Canada for higher standards. Apprentice funding assistance programmes were designed to be completed in a calendar year. Multi-year training programmes have created difficulty in extending apprentice funding to students. When many students cannot obtain the necessary funds to complete the curriculum and with demand being high for certain skills, these students are dropping out earlier to work in the aerospace industry or other industries.

9.4 Industry Acceptance of Training School Graduates

The industry interviews and questionnaire responses indicated that vocational school graduates are being well accepted by the industry. Several firms noted that vocational training schools were their principal sources of obtaining skilled people. The recipients felt that the graduates know the course work and theory, but most felt that graduates were lacking in experience. Industry is optimistically looking for five years of experience in a training school graduate who has only two years of school/experience.

The small air carriers, in particular, indicated that they did not have the experienced AME's to instruct newly hired students. Nor did they have the time to provide adequate on-the-job training for newly hired students. Several companies indicated they would like to have their new employees have a higher mechanical ability rather than a high academic standing. In fact, some recipients felt that the vocational schools' academic standards were too high.

Those candidates with a good mechanical aptitude but with lower academic grades, it was felt, could be excluded from the programme. Some of those who do graduate, on the other hand, have too high an academic standing to be content with working on entry-level jobs assigned to new hires.

Most of the responses indicate that their vocational school graduates which have been hired have a good work attitude. Attitude was cited as a very important criteria in selecting a new hire.

BCIT and Northern Lights both have done an evaluation of their aviation programmes. They asked industry representatives, graduates, early leaving students, current students, instructors, and their advisory committees to comment about the effectiveness of the courses and instruction. SAIT will conduct its first evaluation this year. BCIT conducted its College and Program Review Instruments (CAPRI) survey in 1985. Some 284 questionnaires were distributed and 151 responses were received, most from current students. The industry responses indicated the vocational school was responsive to trends in the field, but noted that increased knowledge was needed in the subject area. Sufficient time was not allocated to teaching the programme. The industry criticized the resources available to the school as well as the equipment and the classrooms and seminar rooms. The most severe criticism from industry was in the area of funding for equipment supplies and instructional development activities for instructors.

The survey revealed that over half of the graduates were not working in the aerospace industry. Similar percentages were cited by SAIT and Northern Alberta Institute of Technology. This may have been due to the after effects of the 1982-83 recession. The US industry also experiences about half of the people studying aircraft mechanics switch to other fields where the pay is equal or better and where there is less regulatory responsibility.[21] Those graduates who were not employed in the industry indicated that the training they received was effective and was of assistance in obtaining a job outside of the aerospace industry.

Northern Lights College conducted a programme review of its AME programmes in 1988. The graduate student survey results noted above average reaction to questions on programme quality and the programme meeting the needs of the

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[21]Ramirez, Anthony, "The worrisome shortage of airline mechanics", Fortune, August 28, 1989

students. Instruction was noted to be above average but there were areas where respondents noted possible improvements.

The practical or "floor work" projects were noted as being good. However, the comments about the content of the programme stated that it needing updating and there needed to be more time spent on modern technology, including turbines and composites. Criticism was expressed about the order in which course content was presented. A more logical liaison was needed between theoretical and practical subjects. The graduate students also noted that future AME students should have a good basic knowledge of Math and Physics, as well as some prior exposure to the industry.

9.5 Centralized vs De-centralized Training Schools

There are only two approved training schools in British Columbia at the present: Northern Lights College and BCIT. There have been suggestions that other aviation schools be established in other areas of the province to increase the number of trained people in the programme. There are examples of other colleges, such as Camosun, offering specific training courses.

The difficulty of a de-centralized training school system is the high cost of maintaining additional instructors and specialized equipment needed at any new school. Building facilities may be available but these physical building costs are minimal in comparison to the on-going annual operating costs of a vocational school. An alternative could be to offer short courses throughout the province, depending on local demand. These courses could be co-ordinated between community colleges and the local aerospace companies. Instructors with specialized knowledge in the subject would be temporarily assigned from BCIT and materials and equipment supplied by the local aerospace companies. Classroom instruction would take place at the local college and practical demonstrations at the premises of the local aerospace firm. Sheet metal and composite repairs course, in particular, could be taught under this concept.

9.5.1 "Centre of Excellence"

BCIT, as one of Canada's leading aerospace training schools, should continue to be the focal training school in the province. It needs to be developed into a "centre of excellence" and take on the added responsibility of co-ordinating and providing quality training in several aerospace skill areas. Other aeronautical skill areas which could be co-ordinated by a "centre of excellence" approach could include flight training, supervision and management instruction and aeronautical science training. It needs, however, to be more independent in its decision making process so it can take on these increased responsibilities on behalf of the aerospace industry. The Pacific Marine Training Institute in North Vancouver is a possible role model. This training institute provides various maritime training needs of the marine industry. Its board of directors is composed of industry representatives who

provide overall guidelines for the training institute to meet marine industry needs. It also ensures there is an on-going liaison between the Pacific Marine Training Institute and the marine industry. An aerospace training "centre of excellence" could also be established using a similar structure. It would be responsive to the needs of the aerospace industry and sufficiently independent to meet these needs.

9.6 Training of Foreign Students

There has been interest in training foreign aerospace students at Canadian aerospace training schools. Canada has a reputation for its high level of training and its advances in aerospace technology. It also has a Pacific Rim strategic advantage of being located next to the giant U.S. aerospace market.

Training of foreign students would provide an export market for Canadian training. Pacific Rim countries in particular may be attracted to an aerospace training school in British Columbia which could accommodate foreign students. The full cost recovery tuition revenue earned from training students could be used to allow the Canadian training schools to expand and acquire facilities and instructors. Interviews with the vocational schools reveal an interest in taking on this additional role. However, the vocational schools point out that training of Western Canadian students should take first priority. If foreign students can be accommodated without disrupting the overall needs of the Canadian aerospace industry, the concept should be encouraged. The additional revenue earned from foreign students may be the catalyst to provide the funds for a long-term education strategy for training and re-training of British Columbians for the aerospace industry.

9.7 Industry Training

Larger companies, such as Canadian Airlines International, operate their own internal training. Canadian Airlines International, for example, has 19 instructors providing a wide variety of various courses including maintenance courses. On-the-job training is important to many of the aerospace companies and most have some type of apprentice or learner type of programme. In recent months, there has been a trend to strengthen company on-the-job training programmes. Japan Air Lines, for example, has established Kensai - quality circle teams of experienced maintenance people working with younger apprentices. The team is responsible for the maintenance of an individual aircraft in the Japan Air Lines fleet. The team paints its name on the aircraft to reflect the team's pride in its maintenance.

Lufthansa German Airlines provides a role model of training. The West German Government encourages companies to invest in the training of young people to produce better workers - and higher quality products. Each year German companies provide on-the-job training for 1.8 million teenage apprentices at

a cost of $10 billion US. This group represents 6 percent of the work force. About 70 percent of German high school students study a vocation. Based on their performance in elementary grades, students are sent to one of three types of secondary schools: Gymnasium or university preparation; Realschule, a middle level school that readies tenth grade students for apprenticeship or further technical training; and Hauptschule, a lower-level school that prepares students for apprenticeships that begin after ninth or tenth grade. Apprenticeships with Lufthansa run for three years. They combine three or four days of on-the-job training with one or two days of classroom instruction at a public vocational school. Wages average $400 US a month. The government sets standards for curriculum guidelines and examination requirements. Lufthansa is not obliged to hire the apprentices they train, nor are apprentices required to remain with Lufthansa. In practice, Lufthansa hires most of the apprentices it trains.

Interviews with industry indicate that on-the-job training effectiveness is highly dependent on the ratio of apprentices to each experienced person. It also depends on the instructional capability of the experienced worker. The experienced worker needs to take the time to explain maintenance and other procedures to less experienced workers. These experienced workers are not provided any special training in how to instruct nor are they provided additional specific wages. Time pressures on the shop floor often limit the practical on-the-job training which can take place.

Computerized maintenance training is now being introduced. These training courses are offered by Wicat Systems, Flight Safety International, Data General and other companies and are normally aircraft specific. These courses are designed for qualified personnel who are taking up-grading or refresher courses for certificates or licence endorsement. The courses are available for the large transport aircraft as well as most business jet aircraft. It is anticipated that computerized maintenance training will be offered in more basic courses soon. Interactive computer training allows the student to work at his own pace at a time that is convenient for the student and employer. Software development costs are expected to decrease as the number of interactive training applications increases. It may offer cost savings since an instructor is not required for all phases of the course. It is expected that the larger firms and training schools will use computerized training where it is cost-effective.

The National Advisory Committee (NAC) referred to earlier, provides a forum where industry, Transport Canada, AME associations, and training schools can discuss training issues and standards. The NAC is developing into an effective organization to deal with national aerospace training concerns. It also has an appreciation of national manpower skill requirements and specific skill shortages. A similar advisory group, which focuses on the manpower needs of British Columbia's aerospace industry, could also be an effective method of planning and co-ordinating the long-term requirements in the province.

10.0 Role of Government and Industry

To solve the skilled labour shortages of the future, there must be a co-ordinated effort by both government and industry. The vocational training schools also have an important role in its relationship with senior levels of government and the aerospace industry. A partnership is needed. No one agency can solve the problem.

10.1 Government Role

The role of government is to assist in areas of continuing education and job training. The recent Employment and Immigration Canada report *Success in the Works - A Profile of Canada's Emerging Workforce* indicates the federal government's commitment to skill training. The report notes that the "human investment needed to benefit from technology - the investment in education, employee training and skills - is too often neglected."[19] It also pointed out "the economy and the labour force appear to be developing along divergent paths, creating a potential gap between the flexibility and skills of workers and the skills our economy will demand."[20] Global competitive pressures, technological changes, and the restructuring of the economy will affect most of the Canadian workforce. Often, upgrading existing skills will not be sufficient and entirely new skills will have to be learned. The same report notes that a growing problem is a mismatch between the skills demanded by employers and those possessed by workers. It concludes by stating "some Canadians will have to meet the challenge not only of changing jobs, but of changing occupations in mid-life. This may entail acquiring new knowledge and learning entirely different skills."[21] The federal government appears to understand the overall Canadian labour force problem The British Columbia aerospace labour market parallels these national problems to a large extent. CEIC is the focal government agency to ensure that its training support is in step with the future needs of the aerospace industry.

The provincial government has a major role as well in skill training.. The Ministry of Advanced Education and Job Training is responsible for vocational training in the province. They are also responsible for administering provincial apprenticeship programmes. The provincial government has to increase its commitment for the promotion of the British Columbia aerospace industry. It must support funding for aerospace training schools and encourage the development of apprenticeship programmes along with industry. An increase in funds is paramount to strengthening the provincial commitment to job training.

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[19]Employment and Immigration Canada, "Success in the Works - A Profile of Canada's Emerging Workforce, Ottawa, April 1989

[20] Ibid.

[21] Ibid.

The Ontario Ministry of Skills Development perhaps presents a role model of the scope of provincial government's involvement. The Ontario government has recognized "economic survival in our technologically-complex world depends on a willingness to grow, to change, to learn." The Ministry has two goals:

- to help individual workers to develop the skills enabling them to find or keep a job;
- to raise the skill level in Ontario so its business and industries prosper in the world economy.

The Ontario government has made a $100 million per year commitment to training to meet its goals. Nearly half of the funds available are for training programmes including industry apprenticeship programmes. The Ministry has an Apprenticeship Branch to maintain and develop apprenticeship training. Standards for certification are set and monitored by the branch. Ontario has about 41,000 active apprentices training in 66 regulated trades combining on-the-job and in-school training. The Ministry of Skills Development expects an increase of 20,000 apprentices in the province within the next five years, including 5,000 women apprentices. The Ontario government training programme should be reviewed as to its relevance to future aerospace training support in British Columbia.

The British Columbia Ministry of Education and the respective school boards also have a role to provide an opportunity to high school students to learn of the career opportunities in the aerospace industry. The Vancouver School Board, for example, has just started an aviation programme for students in grades 11 and 12 at Killarney High School. The programme is designed to increase a student's awareness of career programmes and provides an opportunity for summer employment in the aerospace industry. It is becoming increasingly important to reach students at an earlier stage to introduce the benefits of learning a skilled trade. It is these young people who will be the candidates for vocational school and apprenticeship training.

The vocational schools can benefit from high school students who know their desired career path before attending a training school. Students now can attend two years at an aerospace training school and then realize that an aerospace occupation is not what was wanted. While this graduate is trained, it does not assist in solving skill shortage in the aerospace industry if employment is sought in another industry after graduation. Northern Lights College graduate students, in a recent survey by the school, recommended that prospective students receive exposure to the aerospace industry before taking the AME programme. This exposure may reduce the current attrition.

The aerospace training schools' role is to provide the training and re-training necessary to meet industry standards. It is recognized that only the basics can be taught in a two-year training programme. While the industry, of course, desires a fully trained individual, they are prepared to offer on-the-job training to those graduates who have the aptitude and will obtain the experience.

10.2 Industry Role

The aerospace industry has a very important role to play to ensure that, in the future, an adequate number of skilled workers are available. In the past, the aerospace industry has invested very little in skills training. It hired skilled people from other countries or enticed people from other companies with the inducement of higher benefits. Apprenticeship programmes, where implemented, are the first programs to be dropped in a recession. It is only in the past few years that the industry has recognized that it has a serious problem. There are world-wide shortages of certain skill categories. The US projects a need for 50,000 mechanics for the major airlines alone over the next decade. Skilled people are not available from traditional sources and new ways must be sought such as training its own people.

The aerospace industry's principal role is to provide a commitment to skills training. It has a role to provide on-the-job training. It has to work with the government to organize a recognized apprenticeship/learner program. The program should have standards clearly understood by the government, the employer, and the employee. There has to be flexibility to provide both structured and unstructured training instruction. A long term view to training is required by the aerospace industry to provide the stability needed to provide continuity. A pool of trained personnel is needed to replace retiring workers and to provide the manpower to take advantage of economic opportunities. Apprentices may have to be protected from economic cycles to complete their training and gain needed experience in order to retain them.

The aerospace industry also has a need to promote career opportunities that are available and to improve the image of the aerospace worker. As Air Canada noted in the industry survey "... training alone will not solve the shortage situation. Lack of proper recognition by the public, by the secular/vocational school counsellors and by companies, is our worst problem."[25] The aerospace industry is no longer thought of as a glamour industry. It has to be promoted and marketed to ensure that young people will be attracted to the industry. Canadian Airlines International, for example, will soon start a programme of visiting high schools to provide information on airline careers, including aircraft maintenance career opportunities.

The aerospace industry also has to provide the necessary liaison with the training schools. The aerospace industry has to become more involved in the advisory committees at the training schools. The involvement would provide the input the training schools need as to curriculum and course content. As well, it would advise the training school of the future graduate needs of the industry. The industry should also continue to contribute time and expertise

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[25] Lebou, R.J., Air Canada Maintenance Questionnaire, Interview, July 4, 1989

to the NAC to ensure training standards for skill improvements are met and that these standards reflect industry requirements.

11.0 STRATEGIC PLANNING

A strategic plan is needed for the British Columbia aerospace industry. The plan must be guided by an industry led organization. This organization can effectively co-ordinate the necessary industry and government inputs needed. Future aerospace opportunities may be lost if an industry and government supported strategic plan is not in place to address our aerospace goals. A positive approach will result in achieving the target goal of a viable British Columbia aerospace industry.

Aerospace opportunities are going to be started somewhere and why not in British Columbia. One of the key elements in an aerospace strategic plan is a pool of skilled available labour. Without adequate skilled labour the aerospace opportunities which have been identified will be limited. All the aerospace opportunities of the future rely on a labour force which can readily adapt to changing technology. The labour force also needs the skill level to assure that the highest quality standards are met in providing products and services. The question arises as to how the pool of skilled labour is to be developed. What are the strategic plan actions which must be undertaken? There are also short and long term actions to ensure a logical sequence of events to ensure that skilled personnel will be available when the opportunities arise.

Figure 35, overleaf, demonstrates the key role a skilled labour pool plays to attract future opportunities. Labour availability is not the only criteria but without labour, the other requirements are usually not addressed by companies expanding or creating new businesses. The figure also shows the principal actions needed to develop the pool of skilled labour.

The following lists the possible short and long term actions to meet the requirements in the British Columbia aerospace industry. These actions are also needed to avoid the economic penalty to the provincial economy of not providing for these requirements. These planning actions are based on the findings of the study and are discussed in previous sections.

The Role of Skilled Labour

Figure 35

11.1 Short-Term Planning Actions

There are short-term planning actions which could assist in providing some additional skilled people. These are:

- "CENTRE OF EXCELLENCE"

  Develop an aerospace training "Centre of Excellence" where advanced aerospace training for the province is focused. The centre would have strong industry liaison. It would provide the needed training of new entrants to the industry and the re-training of current employees who need skill up-grading. The centre would require to increase its scope of activities and to have the financial support to take on those additional training responsibilities. It would co-ordinate the instruction needs of all aerospace training including flight training, aerospace management instruction and aerospace science training. The role model for an aerospace centre could be the Pacific Marine Training Institute with its own independent industry led Board of Directors. Because of its expertise in aerospace training and its Sea Island campus facilities, BCIT is the likely institute which could be transformed into an aerospace "centre of excellence."

- COMMUNITY COLLEGE LIAISON

  Continue to support Northern Lights College and other community colleges in the educational system which may wish to offer aerospace training. This could increase the enrolment of students desiring training, particularly those needing only short-term basic courses of instruction. The "Centre of Excellence" training school would be responsible for assisting the local college in providing the course, including instruction assistance. The local aerospace industry would provide equipment and materials needed for the course. Duplication of specialized facilities and equipment throughout the province should be avoided. An investigation into the future role of community colleges in aerospace training and their relationship to a focal "centre of excellence" training school would be worthwhile.

- RETIRED WORKERS

  Recently retired aerospace workers represent a pool of skilled people who could be available on a part-time or contract basis to supplement the current labour force. Industry is interested in using the services of retired workers who have the necessary experience and who are under 65 years of age. An examination of the possibility of using retired workers would be worthwhile. The Pacific AME Association, perhaps, could be the co-ordinating agency between retired personnel and the aerospace industry. It would match skill requirements with the pool of available retired people. The "centre of excellence" would be

responsible for co-ordinating the necessary training for retired workers who require upgraded skills.

- TRANSFER OF SKILLS

  Another short-term strategy is the investigation of the possibility of re-training of workers skilled in other industries which may be down-sizing due to industry structure changes or economic reasons (e.g. the forest industry). These skilled people may have training which is closely related to the aerospace industry and re-training may not be extensive or costly. The industry which the skilled worker is transferring from may also contribute to the cost of re-training as part of an employee retraining and severance plan. Training would be co-ordinated with the aerospace "centre of excellence."

- FOREIGN RECRUITMENT

  Monitoring of world aerospace activities will provide an awareness of difficulties in other regions. This could result in acquiring skilled people who have been laid off due to contract termination or other economic reasons. As noted earlier, Boeing is temporarily using workers from Lockheed-Georgia laid off from the B-1 bomber contract. Bristol in the United Kingdom recently laid off 1000 skilled people. Due to worldwide shortages in certain skill areas, it is not expected that foreign recruitment will be in large numbers. Short-term foreign recruitment will require the co-operation of Immigration Canada.

11.2 Long-Term Planning Actions

There is a requirement to have long-term solutions to solve the skill shortages. A long-term approach will ensure that a skill of trained labour will be available to meet the needs of the future. Despite the variations in economic cycles, there will be a continuing need for trained people. Some of the possible long-term planning actions are:

- APPRENTICESHIP PROGRAM

  The long-term objective of a strategic plan must focus on the training of skills appropriate to the needs of the aerospace industry. The plan not only needs to solve today's skill shortages, but also those in the future. Initiatives have to be taken to attract the type of young person to the industry who will be best suited to it. This is a task not just for the aerospace training schools, but for the aerospace employers. Employers need to share the responsibilities of on-the-job training with government which has skill training and funding responsibilities. Apprentice training has to be part of a long-term strategic plan.

A well-funded apprenticeship program is needed to provide the skills and experience needed by both the industry and the employee. It is the key to assuring that a skilled workforce will be available in the future.

TWO STREAM TRAINING SCHEME

Interviews revealed that development of an additional training stream may offer a long-term solution to skill shortages. A flexible system must provide apprenticeship opportunities for candidates who may be restricted from the AME training program due to their academic standing and Transport Canada's requirement for structured training.

Development of a second stream of training would offer young people with only a grade 10 or 11 level of education the option of becoming involved in the aerospace training. They would take an introductory six-month course and enter the job market to gain on-the-job experience. The introductory course could be given at BCIT or other community colleges in the province. After satisfactory on-the-job training, the apprentice would be sponsored by the employer and the provincial government to take further instruction. Satisfactory completion of an approved course would result in a certificate and an entry in the apprentice's logbook. The apprentice can take advantage of having a continuous on-the-job training and in-school training schedule. Academic courses to improve basic knowledge would also be available. After several years of experience and the required number of certified courses, the apprentice would have the option of remaining as a skilled tradesperson or writing the AME exam and obtaining a licence. The length of time needed would be likely 8 to 10 years before an AME licence could be obtained.

The second stream training concept would allow those people who have the mechanical ability and attitude to enter the industry. Here they would acquire the necessary credentials over a longer period. During this time, they would provide needed skills to the industry. The training concept is similar to the Lufthansa German Airlines apprentice training scheme. It has demonstrated that a flexible system produces and retains skilled people in the industry. It also improves the quality of products and services. It also would be an acceptable apprenticeship program to government for funding consideration.

Figure 36, overleaf, shows the two training stream concept in relation to the traditional AME training program.

Figure 36

Two Stream Training Concept

- SKILLED FEMALE WORKERS

The number of skilled female workers in the aerospace industry is minimal. It is expected by the industry to increase to only one percent by the mid 1990's. Additional skilled female employees could be attracted to the industry but the industry's image has to be improved to encourage female candidates to consider a career in the industry. Female pilots are now accepted. Female maintenance workers will be an increasing factor in aerospace skilled labour.

12.0 CONCLUSIONS

From the analysis of the research conducted in the study, several conclusions can be drawn. They are presented together with an identification of the key recommendations for future action.

The industry must organize itself for a concerted effort can be made to rectify the skill shortage categories identified in the study. An industry led organization is needed to provide the necessary leadership. The organization would have invited participation from training schools, unions, associations and both levels of government. The organization will have to address the two planning horizons which have been noted in the previous section. One horizon is to meet the short-term immediate needs. This will be done by re-training the existing workforce, using retired skilled people, reducing attrition from the industry, and acquiring skilled people available in other regions. A key action required is to establish an aerospace "centre of excellence" to co-ordinate the required training needed to create a pool of skilled labour. The second long-term horizon is the main challenge for the organization. The long-term needs of the aerospace industry have to be addressed to ensure that more and better qualified people will be available. The long-term strategy must focus on the training of young apprentices, both male and female. The apprentices would need skills appropriate to the needs of the British Columbia aerospace industry.

In summary, the study identified the following factors:

- The world aerospace industry has been experiencing extraordinary growth, both in traffic being carried by the airlines and the aircraft manufacturers, trying to keep up with the demand for new airplanes. Continual high growth is expected throughout the 1990's. The Pacific Rim region, in particular, is expected to be one of the brightest parts of the air transport picture. British Columbia's strategic location in this region should provide a significant advantage to its aerospace industry.

- Aerospace opportunities for British Columbia were identified. Also noted were the manpower resources required to capture these existing and future opportunities. These opportunities have to be seized now in order for the industry to grow and become a major aerospace centre.

- The industry survey indicates that the British Columbia aerospace industry employs some 3,660 skilled people. The industry itself, expects that close to 6,000 skilled people will be needed by the year 2000. This represents another 2,260 people who will be needed. This does not include the replacement of 1,110 skilled people who are expected to retire from the industry over the next decade.

- A high growth scenario indicates that up to 8,625 skilled workers are required to meet the demand of several special initiatives. These initiatives would be undertaken to realize the identified aerospace opportunities. A high growth scenario would require nearly 5,000 additional people, not including replacement of people who will be leaving the industry.

- The economic impact of not having sufficient numbers of trained people to meet expected demand is significant. In comparing a negative growth scenario to growth rates expected by the industry, the negative scenario results in some 2,250 fewer skilled people in the industry. It also means the loss of some $70.6 million in lost wages for the British Columbia economy. It would also mean the loss of economic opportunities for British Columbia aerospace firms. If the aerospace window of opportunity is seized, on the other hand, the high growth scenario provides over 8,600 jobs and $270 million in direct wages.

- The employment categories which the aerospace industry expects to suffer from skill shortages include the following in order of skill demand:

    1) Aircraft Mechanic
    2) Avionics/Instrument Technician
    3) Sheet Metal/Structures Technician
    4) Upholsterer/Refurbisher
    5) Engine and Accessory Mechanic
    6) Machinist
    7) Composite/Plastics Technician

- TRAINING SCHOOLS

Aerospace training schools like BCIT, SAIT and Northern Lights College are the principal sources for industry to obtain skilled people. These Western Canadian, Transport Canada approved training schools, however, can graduate less than 200 students in total a year. Many graduates from the training schools, however, do not enter the aerospace industry or obtain an AME licence. Experience indicates that nearly half will switch to other fields and leave aerospace. The "modest scenario" identifies a requirement for 280 additional skilled people each year, significantly more than the current training capacity of the schools. If the skill demands of the "high growth" rate scenario are achieved, some 500 skilled people are needed each year. This is well beyond the current capacity of the training schools. The training schools have to be expanded both in additional equipment and more qualified instructors.

- RECOMMENDATIONS

It is recommended that an aerospace "Centre of Excellence" be established, as a co-ordination centre for all aerospace training. The school would be the recognized aerospace training institute for the province. It would co-ordinate training short-term requirements with regional community colleges to ensure that all British Columbians have access to skills up-grading. It would also be the focal point for co-ordination of other aeronautical training within the community college system and to liaise with industry.

An aerospace training centre could be a positive incentive for employers to retain their existing employees to obtain needed skills. It would also encourage others to enrol in the aerospace training school to begin a career in the industry. An aerospace "Centre of Excellence" will be central to the on-going education and skills training needed for the industry to have the labour resources it needs to be competitive. It is also one of the key building blocks to ensure that British Columbia will have the skilled people to allow its aerospace industry to grow and take advantage of Pacific Rim opportunities.

In order to ensure that aerospace opportunities are seized and that skilled manpower is available for these opportunities, it is recommended that an aerospace co-ordinating group be established to provide the necessary leadership. The group would be led by industry, with participation from the training schools, unions, associations, and the federal and provincial governments.

APPENDICES

APPENDIX A

TERMS OF REFERENCE
LABOUR MARKET STUDY OF THE
BRITISH COLUMBIA AEROSPACE INDUSTRY

Objective:

To undertake a labour market study and skills/training inventory of the current and future human resource requirements in the British Columbia Aerospace Industry, and to assess the economic cost of not providing for these requirements.

The Study:

The study should result in preparation of a profile on the availability, skill levels, training needs and salary/labour rates of management and technical personnel in the aerospace industry.

Specific items which should be addressed are:

- inventory should concentrate on the requirements for the maintenance and manufacturing business in the province. (pilot training is excluded)

- management requirements

- categories of trades/personnel to be profiled should include but not be limited to: sheet metal mechanics, avionics technicians, aircraft mechanics, engineering technologists, aeroengines/jet engines mechanics.

- current situation and forecasted demand of the number of employees in each category (i.e. forecast for 5, 10 years to determine patterns).

- forecasted demand to take into account factors such as attrition, demographics of workforce, technological changes, impact of potential award of certain major crown and private sector projects to British Columbia companies, etc.

- number of union and non union workers, list of unions represented in the industry.

- labour rates/salaries for workforce.

- transferability and obstacles to the transferability of skilled people from other technology sectors.

- identification of new skills required by the workforce during the next 10 years and identification of skills which will not be in demand in the aerospace industry.
- inventory of publicly and privately provided training programs in Western Canada providing services to enhance these skill areas and identification of gaps in training.

- specific recommendations on where to find the required skilled workforce and on actions that could be taken to address any shortages in particular skilled trades (e.g. migration, immigration, military, enhanced training facilities etc).

- the impact on the economy of the British Columbia aerospace industry.

- the impact on the British Columbia economy of not providing adequate human resources to meet the requirements of the industry, (i.e. loss of opportunities, competitiveness)

- observations as to the exportability of training programs.

Definition of the Aerospace Industry:

The aerospace industry can be defined to include design, research, development, production, marketing, repair and overhaul of aircraft, aeroengines and their related components or subsystems, also space related equipment and air/ground based avionic systems.

Time Frame:

The report should be completed within a maximum of 60 days upon award of the contract. An interim report and presentation, and a final presentation to the Steering Committee on the findings of the study are required. A total of 20 copies of the final report must also be provided.

January 24, 1989

APPENDIX B

ASSEMBLER, ELECTRONIC EQUIPMENT (8534-122)

Assembles electronic equipment, such as communications transmitters, radar equipment and telemetering systems:

Mounts component, such as transformers, modules, milliameters, switches and inductors, in cabinets and on chassis or panels. Installs assembled terminal boards in chassis or on panels. Positions wiring harnesses in cabinets, panels and chassis, according to manufacturing standards, and secures them in place, using insulated clamps and hand tools. Attaches leads at cable-assembly break-out points to switches, terminal boards, transformers and connectors, using soldering equipment, spot welder and crimping devices, and following production drawings. Mounts panel assemblies to cabinet or rack, using hand and power tools. Secures plugs of cable assemblies to mating receptacles on panel, chassis or cabinet. Checks continuity of circuits, following drawings and using electrical-test equipment. Replaces defective components, resolders connections, and makes other changes, such as rerouting wires, following inspection reports.

May be designated according to type of equipment assembled; for example,
Communications-Transmitter Assembler
Radar-Receiver Assembler

AIRCRAFT MECHANIC (8582-110)

Services, repairs, and overhauls aircraft and aircraft engines to ensure airworthiness, performing any combinations of the following duties:

Repairs, replaces and assembles parts, such as wings, tail assembly, landing gear, propeller assembly, and fuel and oil tanks, using hand and power tools, and welding equipment to rebuild or replace the airframe or its components. Consults manufacturers' and companies' maintenance manuals to determine feasibility of repair or replacement of parts according to malfunction. Examines engines for cracked cylinders and oil leaks, and listens to detect sounds of malfunctioning, such as sticking or burnt valves. Tests engine operation, using testing equipment to locate source of malfunction. Replaces worn or damaged components, such as carburetors, magnetos and superchargers, using hand tools. Disconnects supply lines, and removes engine from aircraft, using hoist or forklift truck. Disassembles and inspects parts for wear, warping or other defects, using hand tools and measuring instruments. Repairs or replaces defective engine parts. Reassembles, adjusts and tests engine operation for conformance with specifications. Installs engine in aircraft, and connects supply lines. Inspects, services and repairs pneumatic and hydraulic systems. Services aircraft by performing duties, such as flushing crankcase, cleaning screens, greasing moving parts, and checking brakes.

May adjust and repair electrical wiring system and aircraft accessories and instruments. May repair particular types of engines or aircraft and be designated accordingly; for example,
Helicopter Mechanic
Piston-Engine-Mechanic
Turbine-Engine-Mechanic

HEAT TREAT OPERATOR (8133-114)

Controls one or more heat-treating furnaces and quenching equipment to alter physical and chemical properties of different types of metal objects or parts by methods of controlled heating and cooling, such as hardening, tempering, annealing, case hardening and normalizing:

Determines temperature and time of heating cycle and type and temperature of quenching medium to attain specified hardness, toughness and ductility of metal, using standard heat-treating charts, knowledge of heat-treating methods, equipment and properties of metals. Operates oil, electric, electronic induction, or gas furnaces to heat-treat metal objects, using any of the following methods:

1. Relieves internal stresses, softens and refines grain structure in metals.
2. Hardens surface of steel objects by carbonizing or immersing in chemicals during heat process and then quenching.
3. Hardens metal objects by heating and quenching methods.
4. Imparts toughness and removes strains and brittleness by heating previously hardened metal and by controlled quenching sequence.

Adjusts furnace controls, observing pyrometer, to bring metal to prescribed temperature. Places items to be heat-treated in racks, trays or baskets and places them on conveyor or loads them directly into furnace. Observes dials and checks controls to ascertain correct functioning of heat-treat equipment during operation. Removes items after prescribed time and quenches in water, oil, brine or other bath, or allows metal to cool slowly. Maintains temperature and strength of quenching media.

May test hardness of metal objects treated. May set up and operate die-quenching machine to prevent metal objects from warping during quenching. May direct other workers in slinging loads, loading and unloading metal parts or products and in maintaining heat-treating equipment and work area.

SPRAY PAINTER (8595-126)

Prepares surfaces and applies protective or decorative coating, such as primer, paint, enamel or lacquer to ships, aircraft, automobiles, trailers, boiler, pumps, smoke stacks and large surfaces of machines and equipment to provide finished surface, using spray gun, performing any combination of the following duties:

Removes rust from metal sufaces, using acid, scraper, wire brush, emery cloth or steelwool. Cleans and smoothes work surface, using solvents, soap and water, air hose, sandpaper or sanding machine. Applies acid to certain metal surfaces to ensure that paint will adhere to surface. Fills cavities and dents with putty or patching compound to assure smooth finish. Applies masking tape over parts and areas that are not to be coated. Selects coating liquid, adds thinner and mixes solution, using paddle or mechanical mixer to attain required consistency and colour, or selects ready to use paint. Pours coating liquid into spray container and connects gun to airhose, using wrenches. Erects and moves ladder or scaffold to worksite. Climbs ladders or scaffold and climbs onto or moves around workpieces to spray larger items. Turns sprayer valves and nozzle to regulate width and pressure of spray. Pulls trigger to start sprayer and directs spray onto work surface. Coats areas inaccessible to hand sprayer, such as fuel lines and electric controls, using brush. Paints insignia and identifying letters and numbers on surfaces, using stencils and spray gun. Cleans spraying equipment and brushes with solvent. Directs workers in performing duties such as, moving items to work area, and transferring finished pieces to stockroom.

May be designated according to item sprayed; for example,
Painter, Aircraft (air space-craft)
Painter, Boiler (metal fab.)
Painter, Locomotive (rail, rolling stock)

AIRCRAFT INSPECTOR, ASSEMBLIES AND INSTALLATIONS (8526-242)

Inspects aircraft assemblies, such as wings, control surfaces, fuselage sections and landing gear, assembly of components and subassemblies into major structures, and complete aircraft, to ensure adherence to and compliance with standards and specifications designated on drawings and in manuals:

Verifies alignment of parts, and location and finishing of bolt, rivet and other attaching holes, using inspection equipment, such as templates, gauges, jigs and calipers. Checks dimensions, fit and clearances, and correct assembly and operation of components such as landing gear and actuators, using precision measuring instruments and test equipment. Examines engines and accessories, piping and electrical wiring to ensure proper installation. Examines aircraft structures to verify completeness and fastening of equipment, and to determine surface defects, such as scratches and cracks or other evidence of internal damage. Checks fitting and sealing of windows, doors and bulkheads, and fit, colour and quality of seats and upholstery and other internal trim for adherence to standards. Records observations and inspection results on inspection reports and affixes inspection stamp on components and assemblies accepted.

May inspect a particular type of aircraft or assembly and be designated accordingly: for example,
Helicopter Inspector

WELDING AND FLAME CUTTING OCCUPATIONS (8335)
(Welders)

This unit group includes occupations concerned with joining, surfacing, cutting, or otherwise fabricating and repairing ferrous and non-ferrous metal parts and structures, using welding and cutting equipment. Includes activities such as setting up and operating equipment; welding using oxy-acetylene, electric arc, metal inert gas or tungsten inert gas equipment; brazing using oxy-acetylene equipment; soldering using oxy-acetylene or gas blow torch, soldering iron or electric soldering gun; lead burning; cutting or perforating using oxy-acetylene cutting torch or elctric arc cutting equipment.

MACHINIST, GENERAL (8313-154)

Sets up and operates various machine-tools, such as lathes, millers, shapers and grinders, and fits and assembles parts to make or repair mechanisms, tools or machines, applying knowledge of mechanics, shop mathematics, metal properties, lay-out and machining procedures:

Studies specifications and drawings or sample parts and plans sequence of operations. Computes dimensions and tolerances and prepares working sketches from general descriptions and by examining parts and their mating surfaces. Measures, marks and scribes center lines, dimensions and reference points on workpiece, using measuring and marking instruments, to lay out workpiece for machining. Positions workpiece in machine by securing it onto machine table or fixture, into chuck or collet or between centers, manually or using hoist, dial indicator, shims, parallel blocks or clamps. Selects and installs cutting tools in machines. Sets controls and gears to facilitate indexing of workpiece, cutting speed and depth of cut according to type of materials. Starts machine and observes machining progress, and frequently verifies conformance of part to specifications, using measuring instruments; such as, scales, calipers, micrometers and fixed gauges. Finishes and fits parts to mechanisms by filing, grinding, scraping and polishing. Verifies dimensions and alignment, using instruments such as micrometes, height gauges, surface plate and gauge blocks.

May operate assembled or repaired mechanism to test performance.

AIRFRAME ASSEMBLER/SUBASSEMBLER (8515-118)

Assembles airframe by fitting together subassemblies such as fuselage, wing and tail sections and landing gear:

Locates and aligns assembly reference points and holes, using jigs and templates, or calculates relative positions from premarked or known station lines and index points using tape, scales and square. Cuts, files, drills and reams metal, plastic and rubber of assembled units to prepare them for fitting and fastening, using hand and power tools. Bolts and screws brackets, pulleys and flaptracks in position, using wrenches and screwdrivers. Aligns and fits fuselage sections and wing and tail assemblies, using hoists or cranes to position them. Bolts, clamps and rivets assemblies together, using hand and power tools. May verify fit, clearance and alignment of assembled components, using measuring instruments such as gauges and micrometers.

AIRCRAFT FITTER-ASSEMBLER, BENCH (8515-130)

Fits and assembles parts to make aircraft components such as struts, torque-tubes, control linkages, actuators, and wheel assemblies:

Selects, inspects and measures parts to ensure conformance to drawings and production orders. Drills, reams and taps holes, and files, fits, aligns, and bolts parts together, using jigs and fixtures to facilitate assembly, and to set and verify measurements. Tightens and locks bolts and nuts to specification, using torque-wrench, and wire or other specified fasteners.

SHEET-METAL-WORKING-MACHINE OPERATOR (8334-298)

Tends various types of metal working machines; such as, brakes, rolls, shears, rivetting or spot-welding machines to shear, trim, slit, bend, form, crimp, bead and join together sheet metal:

Adjusts stops or guides to specified length as indicated by scale, rule or template. Positions workpiece manually against stops or aligns lay-out marks with die or blade. Pushes button or depresses pedal to activate machine. Checks work, using rule or template. Performs other duties common to sheet-metal shops, such as assisting in moving sheet-metal and products.

REPAIRMAN, ELECTRONIC-EQUIPMENT (8535-114)

Repairs electronic equipment, such as radar, communications, telemetering, data processing equipment and sound-reproducing equipment:

Examines and tests equipment, applying knowledge of functional operation and general electrical and electronic theory, following cirucit diagrams and using electronic-test equipment. Tests electronic components and circuits to locate defects such as shorted capacitors or open circuit in transformer or choke-coil windings, and tests circuits to determine such factors as grid-bias voltage, waveform configurations and radio-frequency output, using capacitor checker, vacuum-tube voltmeter and oscilloscope. Replaces defective components and wiring and adjusts mechanical parts, using soldering equipment and hand tools. Aligns, adjusts and calibrates equipment according to specification, following circuit diagrams and using alignment tools, hand tools and test equipment. Maintains records of repair work.

May install equipment at user's establishment. May install modifications to update equipment. May be designated according to type of equipment repaired; for example,
Communications-Equipment Repairman
Process-Control-Equipment Mechanic
Radar Mechanic

APPENDIX C

C O N F I D E N T I A L

BRITISH COLUMBIA AEROSPACE

LABOUR MARKET STUDY QUESTIONNAIRE

Name of Firm _____

Contact Name _____

Contact Telephone _____

****

A. ABOUT YOUR COMPANY

1. Type of Aerospace Business: (check more than one if applicable)

Air Carrier _____

Corporate Aviation Department _____

Repair & Overhaul _____

Manufacturer/Product Support _____

Other (specify) _____

2. Annual Sales Volume

under $.5 million _____ $.5-1.0 million _____ $1.0-5.0 million ___

$5.0-10.0 million _____ $10.0-20.0 million _____ over $20.0 million ___

3. The percentage of business conducted in British Columbia:

None _____ 1-25% _____ 26-50% _____

51-75% _____ 76-99% _____ All _____

4. Do you export your products or services out of British Columbia?

Yes _____ No _____

If yes, what percentage of your business is export oriented?

None _____ 1-25% _____ 26-50% _____

51-75% _____ 76-99% _____ All _____

5. Do you have a product(s) or service(s) in which you specialize?

Yes _____ No _____

If yes, list specialization(s):

6. Total number of employees in 1988: _____

7. Do you sub-contract work to other aviation/aerospace companies?

Yes _____ No _____

If yes, indicate the percentage of your business which is sub-contracted in the table overleaf:

Percentage		
In B.C.	Out of B.C.	Area of Business Sub-contracted
		Aircraft Maintenance
		Aircraft Repair & Overhaul (e.g. C & D checks)
		Avionics/Electronics/system
		NDT
		Engine Repair & Overhaul
		Propeller Repairs & Overhaul
		Painting/Stripping
		Hydraulics/Systems
		Design & Engineering (including CAD/CAM)
		Structures (sheet metal/composite)
		Machining
		Quality Assurance
		Upholstery/Refurbishing/Cabin Interiors
		Welding/Plating/Anodizing
		Instruments/Accessories/Control Systems
		Tires/Brake Systems
		Other (specify)_____

B. ABOUT YOUR TRADES AND TECHNICAL EMPLOYEES

1. From the following list of trade/technical occupations, please indicate number of employees you have on permanent and part time staff. What is your estimate of the number of trade/technical employees you will require in 1995?

Categories	1988		1995	
	Perm.	Part Time	Perm.	Part Time
Aircraft Mechanic				
Engine & Acc. Mechanic				
Prop/Rotor Blade Mech.				
Fuel Control/Acc. Mech.				
Rotary Wing Mechanic				
Avionics/Instrument Tech.				
Sheet Metal/Structures Tech				
Weld/Plater/Metal Finisher				
Composites/Plastics Tech.				
Tool & Die Maker				
Machinists				
NDT Technician				
Upholsterer/Refurbisher				
Painter/Stripper				
Aerospace Engineer/Designer				
Elect/Electronics Tech/Eng.				
Other (specify) _____				

Comments:

2. Do you experience peak trade/technical employment periods? If so, could you indicate:

Spring _____ Summer _____ Fall _____ Winter _____

3. If your trade/technical employees belong to a union, what is the principal union(s) to which they belong?

4. What percentage of your 1988 trade/technical employees were female? ____

What percentage do your foresee in 1995? _____

5. What percentage of your trade/technical employees are in the following age categories:

Percentage	Under 35	36-45	46-55	Over 55
None	_____	_____	_____	_____
1-25	_____	_____	_____	_____
26-50	_____	_____	_____	_____
51-75	_____	_____	_____	_____
76-99	_____	_____	_____	_____
All	_____	_____	_____	_____

6. Over the last five years, in what geographic areas have you recruited your trade/technical employees?

B.C. _____ Western Canada _____ Eastern Canada _____ U.S. ____

Europe ____ Asia _____ Other (specify) _____

7. Where have the majority of new hires been obtained over the last five years? (Check as many as apply)

Training Institutes (e.g. BCIT) _____ Military _____

Air Carriers _____ Industry Sector (e.g. electronics) _____

Apprenticeship Programs _____ Other (specify) _____

Do you expect to use these sources for new hire recruiting in the future?

Yes _____ No _____

If no, please explain:

8. If you recruit outside of British Columbia, are there particular reasons why?

9. If your company has difficulty retaining skilled trade/technical employees, indicate the most common reasons for these employees leaving your company:

_____ Lay off in firm

_____ Higher paying salary

_____ Additional benefits

_____ Lack of fringe benefits

_____ Employment opportunities in aerospace industry

_____ Employment opportunities outside of aerospace industry

_____ Education/re-training

_____ Other (specify) _____

10. Does your company have any special programmes to motivate and retain employees?

Yes _____ No _____

If yes, what programmes or policies are used by your firm?

_____ deferred profit sharing

_____ frequent salary reviews/increases

_____ bonuses

_____ promotions

_____ development re-training

_____ apprenticeship program

_____ other (specify) _____

11. Do you anticipate increased difficulty in the future recruiting/re-training people with specific skills?

Yes _____ No _____

If yes, check off applicable job classifications and list which specific skills shortages you expect to encounter on the table overleaf.

Categories	Skills Shortages
Aircraft Mechanic	
Engine & Acc. Mechanic	
Prop/Rotor Blade Mech.	
Fuel Control/Acc. Mech.	
Rotary Wing Mechanic	
Avionics/Instrument Tech.	
Sheet Metal/Structures/Tech.	
Welder/Plater/Metal Finisher	
Composites/Plastics Tech.	
Tool & Die Maker	
Machinists	
NDT Technician	
Upholsterer/Refurbisher	
Painter/Stripper	
Aerospace Engineer/Designer	
Elect/Electronics Tech/Eng.	
Other (specify) _____	

Comments:

12. Do you expect employees to have multi-skilling qualifications to provide a broader range of skills?

Yes _____ No _____

13. Would you consider hiring recently retired workers who have the qualifications and skills you require?

Yes _____ No _____

14. Do you see any changes in existing or expected technology which will affect the type of skills your firm will require?

Yes _____ No _____

If yes, identify the technological changes and explain how this will affect the demand for skilled people.

15. What are the average hourly wages/salary for trade/technical employees in your company?

Percentage	Entry Level	< 3 Years with Company	> 5 Years with Company
< $10/hr	_____	_____	_____
$10-15/hr	_____	_____	_____
$15-20/hr	_____	_____	_____
$20-25/hr	_____	_____	_____
> $25/hr	_____	_____	_____

16. What are the desired requirements of your company for new hire trade/technical employees?

Education:

Less than High School _____ High School _____ Technical College _____

University _____

Years of Experience:

None _____ 1-2 years _____ 3-5 years _____ over 5 years _____

Licences/Certificates:

AME _____ Other (specify) _____

A _____ R _____ B _____ E _____ D _____ P _____

Other (specify) _____

Specific Aircraft Endorsement: _____

Comments:

C. YOUR COMPANY'S TRAINING PROGRAMME

1. Is your firm involved in any training programmes (other than informal on-the-job training)?

Yes _____ No _____

If no, skip to question 7.

2. Internal Training Format (check more than one if applicable)

Classroom _____ Seminar _____ Workshop _____ Home Study _____

Apprenticeship/Learner Programme _____ Other (specify) _____

	INTERNAL TRAINING		EXTERNAL TRAINING	
	DURATION Days	FREQUENCY Times/yr.	DURATION Days	FREQUENCY Times/yr.
Aircraft Maintenance				
Engines				
Structures				
Avionics				
NDT				
Other (specify)				

3. External Training Provided by: (check more than one if applicable)

Manufacture Training _____

Educational Institution _____

Trade or Union Sponsored Association Seminar _____

Other (specify) _____

4. How many trade/technical employees have received training in 1988?

In House _____

External _____

5. Have you received any assistance for training programmes from any Federal or Provincial Government agencies? (eg., Industrial Adjustment Service)

Yes _____ No _____

If yes, describe type of assistance.

If no, would you be interested in obtaining Federal or Provincial training assistance in the future?

Yes _____ No _____

6. If you use external training, does it meet your company needs?

Yes _____ No _____

If no, please explain.

7. What type of training programmes do you suggest would be useful to your company in meeting its existing and future requirements for skilled employees?

D. YOUR COMMENTS AND VIEWPOINTS

1. If you have any additional comments or viewpoints, we would be pleased to hear from you.

PLEASE RETURN THE QUESTIONNAIRE BY MAY 26, 1989

THANK YOU FOR YOUR CO-OPERATION

McNeal & Associates Consultants Ltd.
331 Rabbit Lane
West Vancouver, BC V7S 1J1
273-8471

BRITISH COLUMBIA AEROSPACE LABOUR STUDY

AEROSPACE ISSUES

Aerospace Issues	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. There should be tougher regulations regarding aircraft age, corrosion inspection, and other airworthiness factors to ensure safer aircraft.					
2. All employees who work on aircraft should have the appropriate certification and/or license.					
3. Transport Canada should be the only agency to issue aircraft/system endorsements, not the air carrier or manufacturer.					
4. The proposed changes in AME endorsements will provide the required responsiblity of appropriate work tasks and inspections.					
5. The lack of qualified replacements for skilled employees makes the BC aerospace industry vulnerable to competition from other technology industries.					
6. There should be more consultation and cooperation between technical training institutes and members of the aerospace community.					
7. There should be greater emphasis on upgrading and retraining current employees.					

Aerospace Issues	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
8. There is a need for government to provide more training programs that support the B.C. aerospace industry's efforts.					
9. There is a need for technical training institutes to adopt a curriculum which reflects changing industry requirements.					
10. Additional skilled people can be attracted to the aerospace industry by increasing wage rates.					
11. There is a need for additional inspection and recording procedures in aircraft manufacturing/ maintenance.					
12. Skills from other industry areas can be readily transferred to the aerospace industry.					
13. The B.C. aerospace industry has the economy-of-scale size to be effective in its future development.					
14. New employees have the necessary dedication and pride in the aerospace industry.					

Aerospace Issues	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
15. Deregulation of air transport has created opportunities in the aerospace industry.					
16. Aerospace apprenticeship programmes should be recognized by the government.					
17. Aerospace unions have a large role in shaping the future of the aerospace industry.					
18. Current procedures for obtaining an AME license are adequate to meet both industry and safety needs.					
19. Transport Canada should have practical tests as well as exams for obtaining a license.					
20. Current experience requirements for an AME license are not adequate for the needs of the industry.					
21. The aerospace industry should provide a commitment to technical training schools for a minimum number of graduates each year.					
22. The aerospace industry is responsible for providing both formal and on-the-job training for its employees towards credit for an AME license.					

APPENDIX D

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THE ASIA PACIFIC INITIATIVE

On December 16, 1986, federal and provincial ministers signed a Memorandum of Understanding (M.O.U.) calling for the coordination of initiatives to enhance British Columbia and Vancouver as Canada's Pacific Centre for trade, commerce and travel. The M.O.U. was later designated as the Asia Pacific Initiative.

On June 2, 1987, the Asia Pacific Initiative Advisory Committee (APIAC) – drawn from the private sector – was established to advise federal and provincial ministers of initiatives that might be undertaken to achieve the objectives of the M.O.U. This advice is transmitted by the APIAC to the federal-provincial Pacific Council of Ministers through a Ministerial Executive Committee that meets regularly with the APIAC.

The APIAC has appointed task forces that are addressing opportunities and advising the Governments of Canada and British Columbia in the areas of international finance, trade, transportation, tourism, cultural and social impact and the export of professional services. More than 100 volunteers from the private sector are engaged in this work.

ASIA PACIFIC INITIATIVE